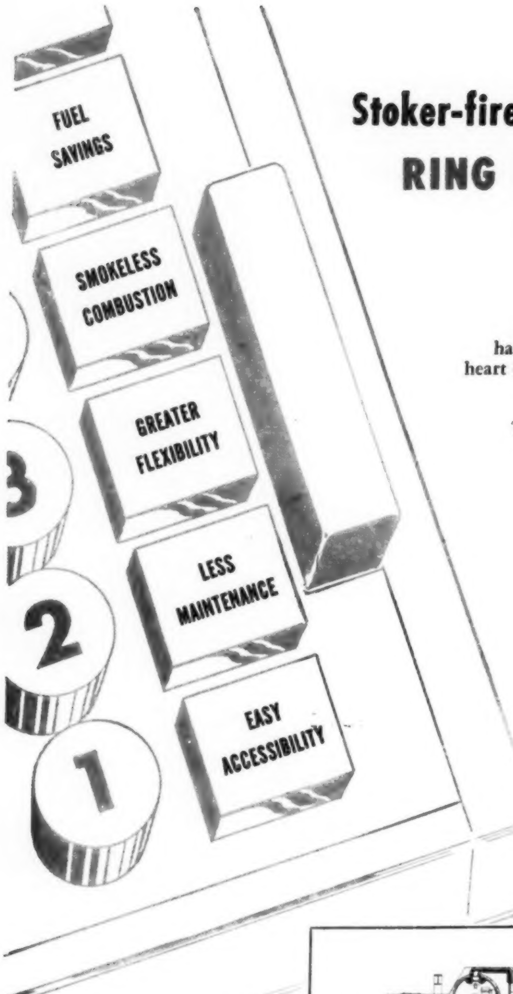
MECHANICAL ENGINEERING

• MAY 1951 •

Departments

ASME SEMI-ANNUAL MEETING — Toronto, Ont., Canada, June 11-15, 1951



Stoker-fired B&W boilers
RING UP LOWER STEAM COSTS
at National Cash Register

The National Cash Register Company, Dayton, Ohio, had a difficult steam generating problem. Located in the heart of its beautiful factory adjacent to a lovely residential section, its power plant was required to minimize pulverized coal fly-ash and smoke from its stack.

To the pulverized coal-fired boiler plant, the company added a B&W stoker-fired boiler of 100,000 lbs. per hour steam capacity.

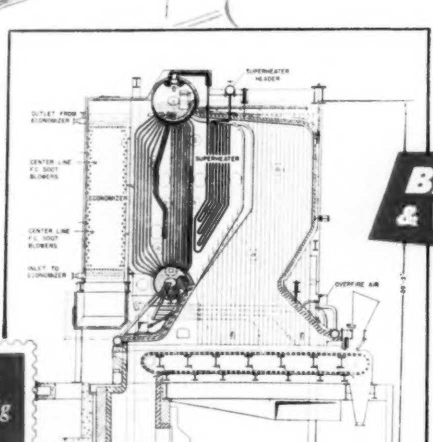
The new boiler more than satisfied expectations. With proper coal it operates at ratings up to 40% overload with complete absence of smoke. It permits the use of less costly strip-mined coals, which replace coals that deliver in Dayton at almost 50% higher prices.

It operates at high thermal efficiency with quick response over a wide range of loads and fuels, and provides trouble-free service at remarkably low maintenance cost.

On the basis of its performance a duplicate boiler was recently installed.

Perhaps you have similar boiler or fuel-burning problems . . . are considering expansion or an entirely new power plant. Why not, like so many others, get the benefit of B&W's 80-year leadership in design, engineering, and building for steam-generating economies.

The Babcock & Wilcox Co., 85 Liberty Street, New York 6, N. Y.



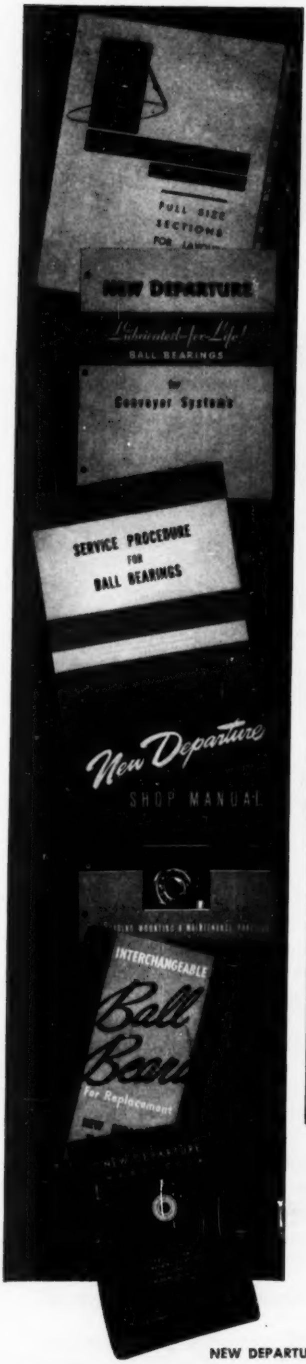
Another Example of B&W Engineering for Economy

BABCOCK & WILCOX

B&W

G-502

Complete Information on Ball Bearings



At your fingertips . . .

New Departure's library of technical books for engineers and designers contains the most complete, practical and authoritative data available in the ball bearing industry.

This specialized information, gained from years of experience and exhaustive field and laboratory research, is available to you under the single-subject headings listed below.

Personal consultation with New Departure engineers is important, while your design is in the formative stage.

When writing for copies of these books please use your company letterhead, and identify titles by their code letters.

CODE Letter

BOOKS ON DESIGN

CODE Letter	
BA	Bearing Application (Part I)
DD	Details of Design (Part II)
EL	Enclosure & Lubrication (Part III)
LC	Bearing Load Computation (Part IV)
AP	Application Procedure (Part V)
LF	Full Scale Drawings of Bearings
H	Tables, formulae, bearing principles, load computation, bearing installation

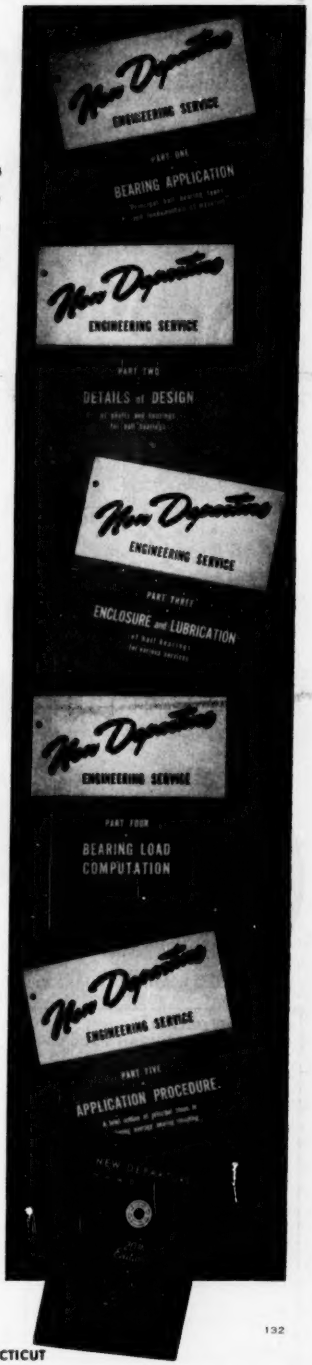
MAINTENANCE AND SERVICE

SP	Service Procedure for Ball Bearings
R	Interchangeable Replacement Bearings
FW	Front Wheel Adjustment Chart

GENERAL

S	Standard Catalog (Handbook, Vol. I)
BI	Explanation of numbering system
D	Sealed bearings (Discussion of Principles)
IB	Sealed Bearings with provision for relubrication
BM	How Steel Balls Are Made
DE	Decimal Equivalent Tables (4 sizes)
T	Why Anti-Friction Bearings (Discussion of Fundamental Principles)

—and many other titles too numerous to mention. Tell us your needs.



NEW DEPARTURE
BALL BEARINGS

Nothing Rolls Like a Ball

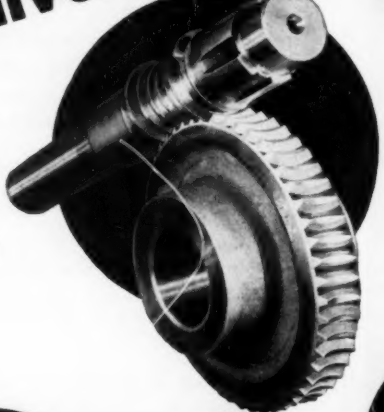
132

NEW DEPARTURE • Division of GENERAL MOTORS • BRISTOL, CONNECTICUT

MECHANICAL ENGINEERING, May, 1951, Vol. 73, No. 5. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

For Editorial Contents See Page 373

You get them all with Cone-Drive Double-Enveloping Gears—



LONGER LIFE ?

"HYDRAULIC" SMOOTHNESS ?

SMALLER GEARS ?

STRONGER GEARS ?

SIMPLER GEAR DESIGN ?

GREATER LOAD CARRYING CAPACITY ?

From the instant any two teeth of a Cone-Drive double-enveloping gear set come into engagement, they are engaged for their full depth and they stay that way—in full depth engagement—until they come out of engagement one-eighth of a revolution later.

To put it another way: ⅛ of all teeth in the gear of a Cone-Drive double-enveloping gear set are in continuous full depth engagement at all times.

This is possible because in Cone-Drive double-enveloping gears the teeth of the pinion are wrapped around the gear and the teeth of the gear are wrapped around (envelop) the pinion.(*)

This characteristic is what gives Cone-Drive Gears their high load capacity for a given size and weight, their quietness in operation, their "hydraulic" smoothness, their long trouble-free life.

(*) *Helical and spur gears are non-enveloping. Conventional worm gears are single-enveloping.*

CONE-DRIVE GEARS
DIVISION OF MICHIGAN TOOL CO.
7171 E. McNichols Rd.
Detroit 12, Mich.

Please send me without obligation further information on double-enveloping Cone-Drive Gears. We are particularly interested in the following:

Horsepower_____to_____

Ratio ____/1 to ____/1

Name_______________

Title_______________

Company_______________

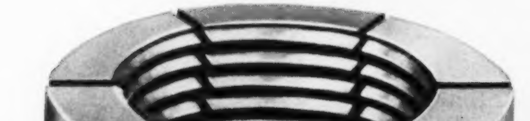
Address_______________

CONE-DRIVE GEARS
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
Division Michigan Tool Company
7171 E. McNichols Road • Detroit 12, Michigan

FLEXLOC®

SELF-LOCKING NUTS

STAY TIGHT AFTER 171,360,000 VIBRATIONS AT 4,000 CYCLES PER MINUTE



FLEXLOC Self-Locking Nut, "regular" type. FLEXLOC Self-Locking Nut, "thin" type. FLEXLOC Self-Locking Nut, external wrenching type.

Plain nuts with lock washers loosened after only ONE HOUR of 4000-cycle-per-minute operation on the vibrator of a concrete block machine at the plant of the Bethayres Concrete Block Co., Bethayres, Pa.

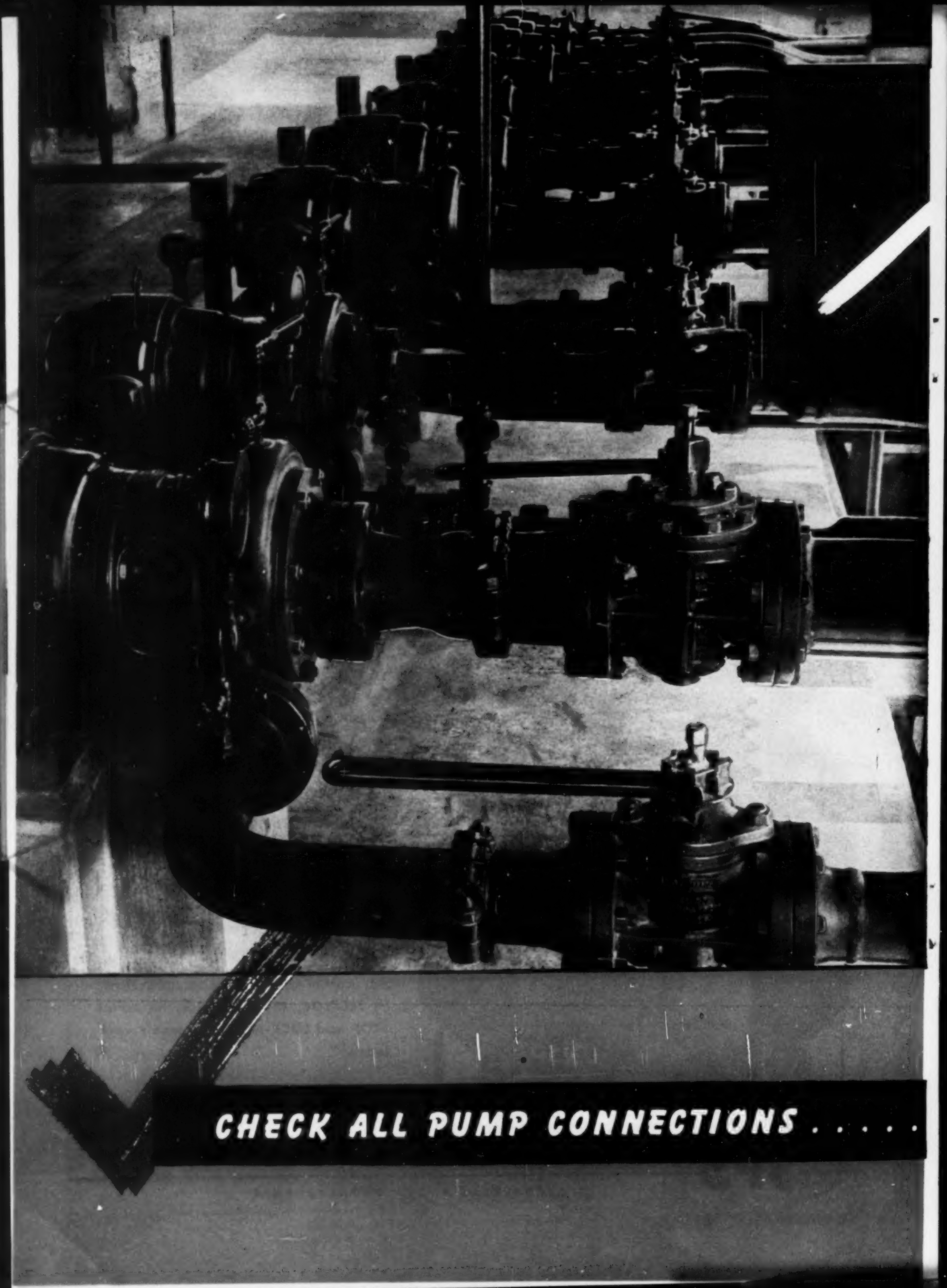
When FLEXLOC Self-Locking Nuts were installed, they were *still tight* when the machine was torn down for rebuilding after 6 weeks operation—at 4000 C.P.M., 17 hours a day, 7 days a week!

So if you have an application where plain nuts might or actually do loosen and back off, try ***FLEXLOC, the one-piece, all-metal STOP-and LOCK-NUT "that won't work loose."***

Send for Bulletin 619-A today.

SPS STANDARD PRESSED STEEL CO.

JENKINTOWN 20, PENNSYLVANIA


CHECK ALL PUMP CONNECTIONS . . . .

Adopt this new habit

Valve failure on pump lines is a hazard, especially in closed areas and where every precaution must be taken to avoid disaster. Some operators follow an old and dangerous habit of merely replacing a troublesome valve with a like valve, assuming that the new "old" valve will be a remedy. But if the old valve were right in the beginning it probably wouldn't need replacing.

Get the new, improved habit—replace with Nordstroms. Recheck each valve on your pump connections. Requisition Nordstroms. Make this standard practice—and eventually you'll have a really up-to-date set of valves that will end your valve problems permanently.

Nordstroms save space in restricted pump locations. They give positive shut-off because a quarter turn of the plug is an absolutely sure operation as contrasted with a valve dependent upon an exposed disc and seat that must be jammed together.

Nordstrom Valves

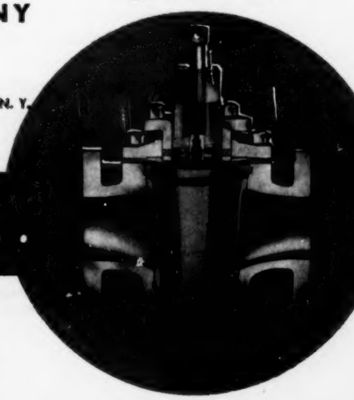
NOW AUTOMATICALLY LUBRICATED WITH TRADE MARK **Hypermatic** PATENTS APPLIED FOR

ROCKWELL MANUFACTURING COMPANY
400 North Lexington Avenue, Pittsburgh 8, Pennsylvania

Atlanta, Boston, Chicago, Columbus, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa . . . and leading Supply Houses.

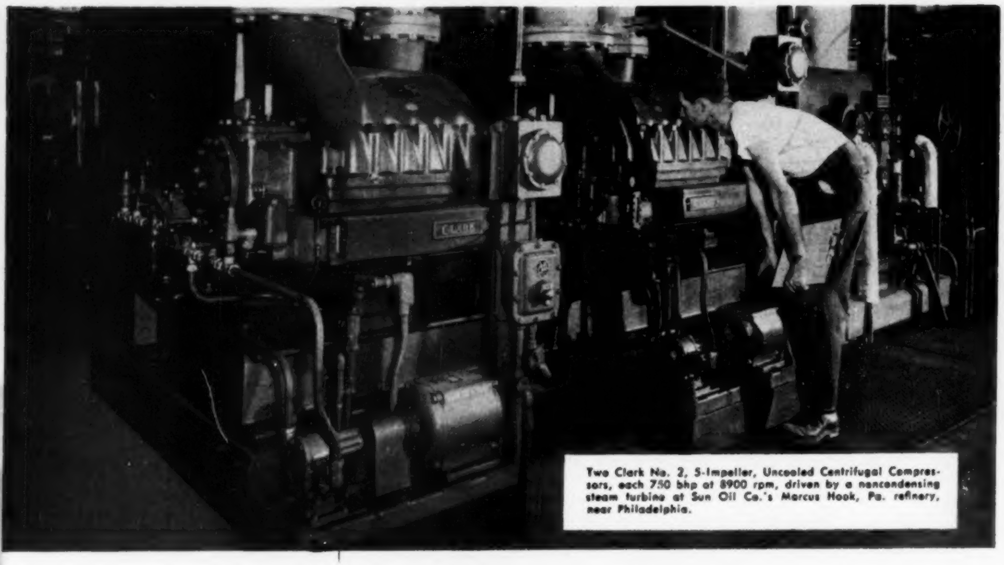
ROCKWELL r

Export: International Division, Rockwell Manufacturing Company, 7101 Empire State Bldg., New York 1, N. Y.



. . . . FOR REPLACEMENTS AND . . .

to avoid hazards of leakage
INSTALL NORDSTROMS



Two Clark No. 2, 5-Impeller, Uncooled Centrifugal Compressors, each 750 bhp at 8900 rpm, driven by a noncondensing steam turbine at Sun Oil Co.'s Marcus Hook, Pa. refinery, near Philadelphia.

UNIQUE APPLICATION BY SUN OIL'S MARCUS HOOK REFINERY

Conserves Energy, Cuts Costs

✓ In feeding air system network
✓ In reducing steam pressure

Wherever steam is available and space is at a premium, Clark Centrifugal Compressors have long been recognized as the ideal source of shop air. *That's a widely known fact!*

But, Sun Oil Company's refinery at Marcus Hook, Pa. had an additional and unique reason for recently installing two of these Clark units: They were most economically suited to the energy-conserving, cost-cutting system, which Sun had engineered, to accomplish in one continuous operation — (1) The feeding of the refinery air system network, and (2) The reduction of large volumes of steam from 400 to 135 psi pressure.

By using a noncondensing steam turbine to drive two Clark No. 2, 750 bhp (each), 5-Impeller, Uncooled Centrifugal Compressors, and simultaneously reduce the steam pressure, Sun has come out far ahead. Available steam is being utilized to economically serve air requirements (the unit compresses 6150 cfm of air from the atmosphere to a discharge pressure of 110 psig). Large losses of energy, inevitable with the use of a reducing valve, and high costs involved in the use of a boiler, have thus been avoided.

To be current on the economy of Clark Centrifugal Compressors for *your* plant, write for literature and consult with your nearest Clark representative.

CLARK
Centrifugal COMPRESSORS

SEE the difference in CLARK COMPRESSORS
MIDGET ANGLE • RIGHT ANGLE • BIG ANGLE
ELECTRIC-DRIVEN • CENTRIFUGAL

CLARK BROS. CO., INC.
One of the Dresser Industries
OLEAN, N. Y.

New York • Tulsa • Houston • Chicago • Boston • Washington • Los Angeles • Birmingham • Detroit • Salt Lake City • San Francisco
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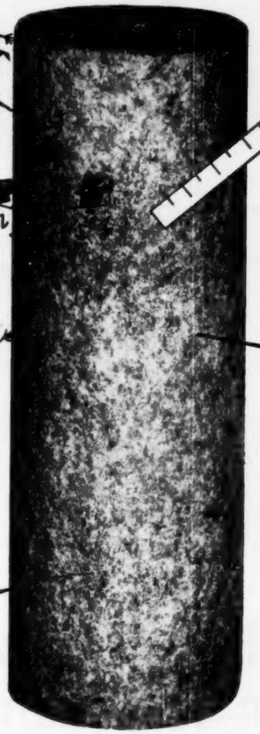
Which Design

answers your most important problems about micronic filtration?



WHICH

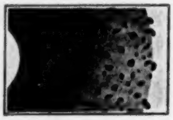
is the only micronic filter that works by a positive mechanical principle?

Cuno **MICRO-KLEAN** cartridge consists of tiny fibres distributed under scientific control and resinous impregnated and polymerized to prevent softening, swelling, hardening, shrinking, rupture or channelling. Solids are simply entrapped in the interstices—no other means is utilized. Densities: 10, 25, 50 microns. Wide range of fluids, flow rates and capacities (from a few to more than 800 gpm). Single or multiple cartridge units.

WHICH FILTER

needs the least amount of room?

Cuno **MICRO-KLEAN** cartridge is utterly simple. It's all filter, no structural components. This means less space needed—and makes *full-flow filtration* practical for either external or built-in applications.



WHICH FILTER

is guaranteed for specific performance?

Felting of fibres is accurately controlled for various densities . . . so that a Cuno **MICRO-KLEAN** of a given density will positively remove 100% of all solids for which it is rated, plus a large percentage down to 1 micron.

Longer life—Exclusive "graded density in depth" permits smaller particles to penetrate to varying depths—doubles dirt-holding capacity.

Low pressure drop

Changing cartridge is quick—and clean.

No Fluid Is Better Than Its Filtration

CUNO

Complete Line

Fluid Conditioning

Removes More Sizes of Solids from More Types of Fluids

MICRONIC Micro-Klean • DISC-TYPE Auto-Klean
WIRE-WOUND Flo-Klean

Mail this Coupon . . . for FREE Catalogs

Make Sure to Investigate MICRO-KLEAN First

- ☐ Lubricating Oil
- ☐ Hydraulic Oil
- ☐ Water and Water Solutions
- ☐ Compressed Air
- ☐ Fuel Oil
- ☐ Acids

CUNO ENGINEERING CORPORATION
6514 South Vine St., Meriden, Conn.

Please send information on Cuno MICRO-KLEAN for services checked.

Name.......................Title...............

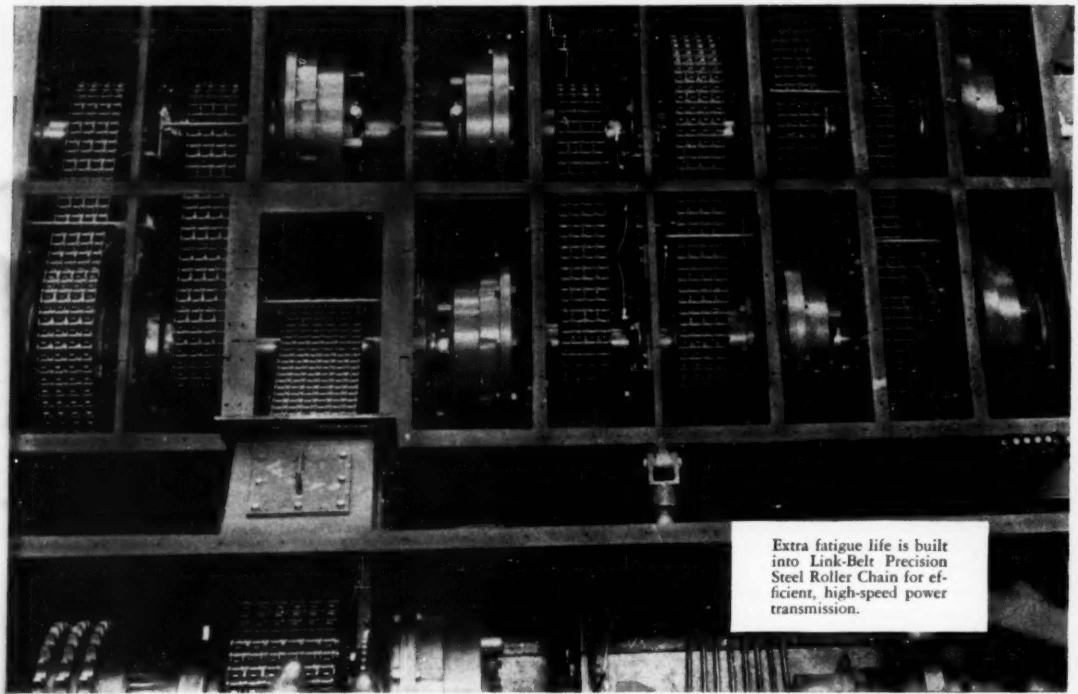
Company...

Address...

City...........................State..........

PLEASE ATTACH COUPON TO YOUR BUSINESS LETTERHEAD

No ONE chain serves



Extra fatigue life is built into Link-Belt Precision Steel Roller Chain for efficient, high-speed power transmission.

LINK-BELT builds the world's most complete chain line... offers you the RIGHT chain for your specific requirements

Silent chain, for smooth, high-speed drive service, from fractional to 2500 horsepower.

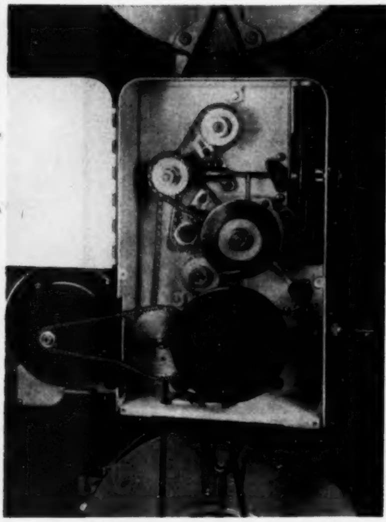
Precision steel roller chain, for long-lasting drives and conveyors, also double pitch and multiple widths.

Class SS bushed roller chain, of many designs, for drives, conveyors and elevators, rugged and durable.

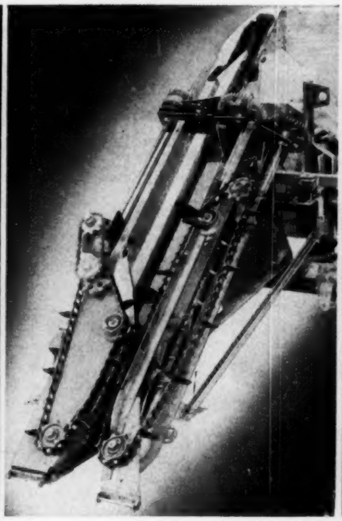
Combination chain, with cast links pin-coupled to steel sidebars, for rugged conveyor and elevator duty.

Class H pintle chain, one of many cast of malleable iron or stronger Promal, with closed pin joints.

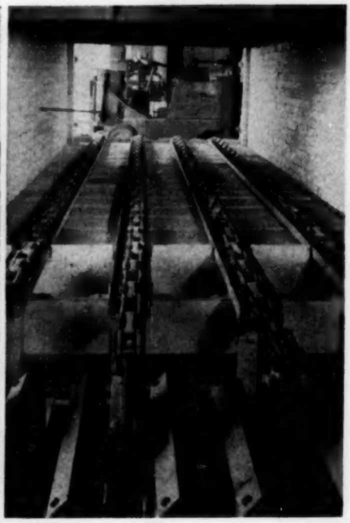
every purpose...



3/16" pitch, smallest of a large family of fast-running silent chains, assures accurate speeds in this theatre sound projector.



For this farm machine, Double-Pitch Roller Chain and Steel Link-Belt were selected to meet specific drive and conveying needs.



Long life under severe conditions. Here L-B drop-forged steel rivetless chains move castings through a heat-treating furnace.

THERE'S just *one* type of chain that *best* meets the requirements of any given job. And no "general purpose" chain can do it as well. That's why Link-Belt builds the world's most complete line of chains and sprocket wheels.

There's a Link-Belt chain for every job—Silverstreak Silent Chain for high speed drives up to 4000 fpm and 2500 hp... Precision Steel Roller Chain for moderately high-speed drives and conveyors... any one of dozens of steel and malleable chains for power transmission, conveying and elevating service with an infinite variety of attachments. Large or small, Link-Belt builds them all.

Remember, too—when you see a chain with the Link-Belt trademark, you can be sure it's made to the highest standards. Link-Belt's modern plant facilities assure greater refinements of manufacture. Exact control of materials and processes gives increased uniformity... longer chain life.

12,343

LINK-BELT

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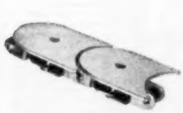
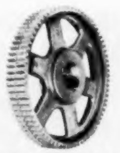


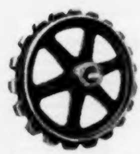
Class RC crescent flat top chain, conveys bottles, cans, etc. separately over curving paths; various designs.

Steel Link-Belt, similar coupling to cast Ewart Detachable, economical for light drive and conveying service.



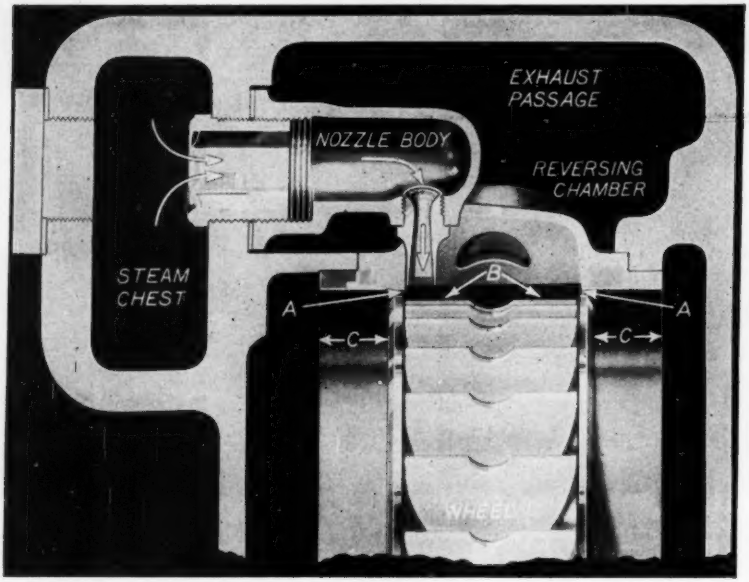
Silent chain wheel, precisely machined to mesh with chain, in a full range of diameters, widths and designs.

Roller chain sprocket, with accurately cut, hardened teeth, in all diameters, widths and hub designs.



Cast tooth sprocket, gray iron, steel or file-hard Flint-Rim, for cast, combination, forged or fabricated chains.

TERRY



AMPLE CLEARANCES FOR DEPENDABILITY

Large blade and rim clearances and extra large side clearance — one inch — help make Terry One-piece Wheel Turbines highly dependable in operation.

The blades cannot foul because of the protection afforded by the rims, which are not damaged, should rubbing occur.

Note the rim clearance, AA in diagram. Also the large blade clearance, B. Side clearance, CC, is so large that end-play from external thrust cannot damage wheel.

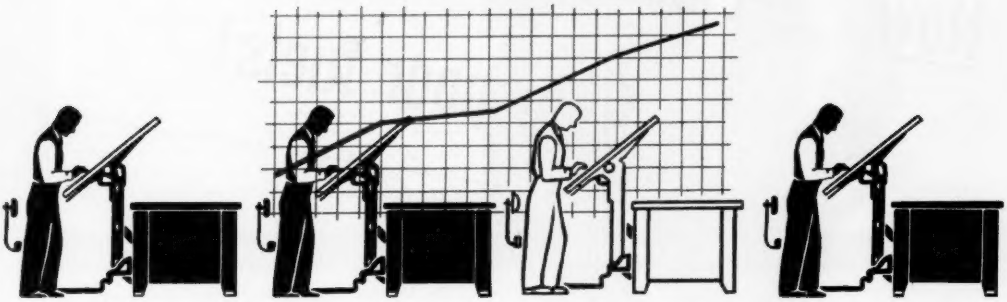
Terry Bulletin S-116 will give you full information on the Terry Wheel Turbine. A request on your business letterhead will bring you a copy.

T-1171

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

When 3 draftsmen *must* do the work of 4

Hamilton Auto-shift Tables are the answer!



Actual case histories offer proof that the installation of Hamilton *Auto-Shift* Tables brings drafting room production up, up, up. Why? Because *Auto-Shift* is the most *flexible* drafting table ever built. Instantly, effortlessly, your draftsmen can adjust this remarkable board to the most efficient, most relaxed working position. Fatigue goes down, productivity goes up!

Drafting room miracles are being called for again!

And how can you best answer the call? By adding skilled men if and when you can find them—and even more important, more practical—by increasing your daily output-per-man. And for mighty impressive proof that this can be done, contact your nearest Hamilton Dealer for a working demonstration of the Hamilton *Auto-Shift* Drafting Table.

Whether you have a D.O.-rating or not, see your Hamilton Dealer at once to insure earliest possible delivery.

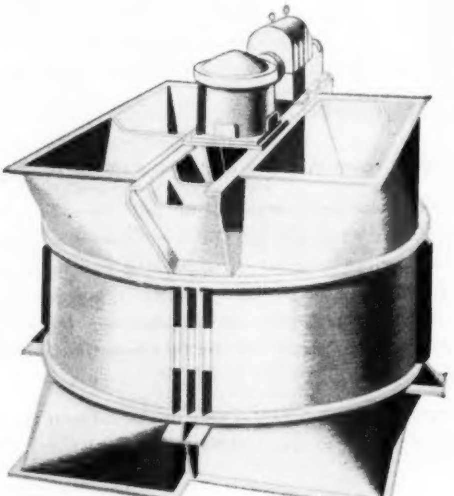
HAMILTON WORK-DESIGNED DRAFTING EQUIPMENT

Hamilton Manufacturing Company

TWO RIVERS, WISCONSIN

Now... get better results from poor fuels!

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.



Problems presented by today's available fuels hold fewer complications in those boiler plants equipped with Ljungstrom Air Preheaters.

High temperature combustion air is the key factor to efficient combustion of low-grade fuels, especially coals with high ash or moisture content. With the Ljungstrom Air Preheater it is possible to obtain higher preheat more economically.

In addition, the *continuous regenerative counterflow principle* of the Ljungstrom permits reliable operation at low exit gas temperature. This assures the greatest possible heat recovery . . . reduces the amount of fuel required.

If you are planning a new installation, or modernizing your present one, our engineers will welcome the opportunity to show you how the Ljungstrom can enable you to get better results from low-grade, less costly fuels.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

A FOOTE BROS. DRIVE

FOR ANY POWER TRANSMISSION NEED

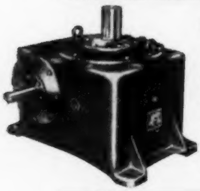
Any requirement for power transmission equipment can be met from Foote Bros. complete line of enclosed gear drives.

Nearly a century of engineering and manufacturing experience is back of these drives. Three large plants contain the newest in gear cutting equipment. New techniques in manufacture—better control of materials—improved manufacturing methods—all assure superior enclosed gear drives. Mail the coupon below for bulletins in which you are interested.

LINE-O-POWER

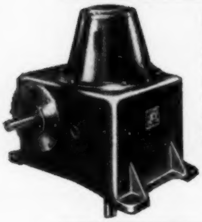
Economical in original cost and operation, these drives incorporate Duti-Rated Gears which have file-hard tooth services and ductile cores, assuring long life. Compact in design. Available in double or triple reductions, with ratios from 5 to 1 up to 238 to 1 and capacity range from 1 up to 200 horsepower. Write for Bulletin LPB.

VERTICAL DRIVES



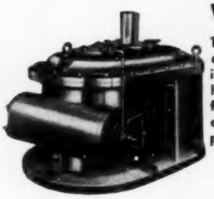
HYGRADE

A quality line of heavy-duty drives, incorporating precision worm gearing that assures high efficiency and load-carrying capacity. Vertical output shaft may extend upward, downward or both. Ratios from 4⅛ to 1 up to 4,108 to 1. Capacity up to 260 horsepower. Write for Bulletin HGA.



HYTOP

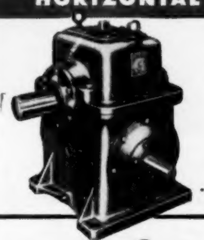
Similar in design to the Hygrade Vertical Drives, but with wider, low-speed bearing span to accommodate long, unsupported vertical output shaft extensions. Vertical output shaft may extend upward, downward or both. Write for Bulletin HGA.



WORM-HELICAL

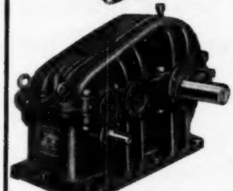
These drives are admirably suited to applications which require horizontal input and vertical output shafts for heavy-duty service. Available in ratios from approximately 30 to 250 to 1 and a capacity range up to 120 horsepower. Write for information.

HORIZONTAL DRIVES



HYGRADE

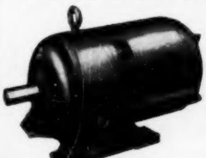
High quality, heavy duty, enclosed worm gearing that assures high efficiency and load-carrying capacity. Available in a wide range of types to meet any need. Ratios from 4⅛ to 1 up to 4,108 to 1. Capacity up to 260 horsepower. Write for Bulletin HGA.



MAXI-POWER

Heavy-duty helical gear drives. Available in single reduction units, ratios up to 9.91 to 1; capacities up to 1,550 horsepower; double-reduction units, ratios from 9.32 up to 71 to 1, capacities to 1100 horsepower; triple reduction units, ratios from 79 up to 360 to 1, capacities up to 420 horsepower. Write for Bulletin MPB.

FOOTE BROS.-LOUIS ALLIS *Gearmotors*



A compact line of gearmotors in 17 sizes in single, double and triple reductions, incorporating Duti-Rated Gears that assure long wear life and maximum load-carrying capacity. Units use Louis Allis high quality motors—available in a wide range of enclosures to meet any condition. Write for Bulletin GMA.

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard, Chicago 9, Illinois

FOOTE BROS.

Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation
Dept. Q, 4545 South Western Boulevard, Chicago 9, Illinois
Please send me the bulletins checked below:

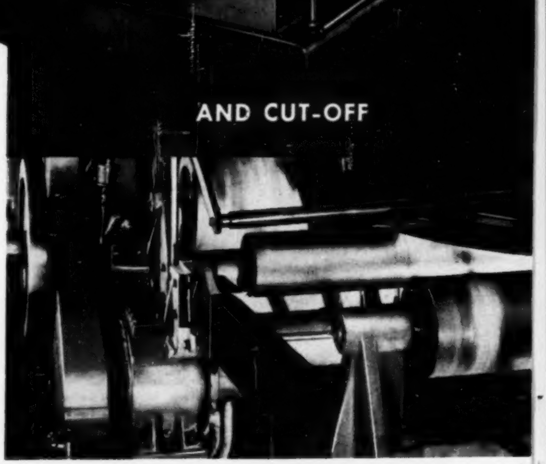
- ☐ Bulletin HGA { Horizontal Hygrade / Vertical Hygrade / Vertical Hytop
- ☐ Bulletin LPB Line-O-Power
- ☐ Bulletin MPB Maxi-Power
- ☐ Bulletin GMA Foote Bros.-Louis Allis Gearmotors

Name..*Position*..............................

Company..

Address...

City..*Zone*..........*State*..........................



Oilgear drive installed in 1934 operates 16 hours daily at low cost. Gives maximum production on all stocks with little spoilage or non-productive time

A laminating machine and a cut-off in the plant of the Chicago Carton Company are driven in synchronism by Oilgear Fluid Power Equipment installed in 1934. A trip to the plant reveals today the compact, sturdy Oilgear equipment on the lower floor performing quietly, efficiently and continuously 16 hours a day in the necessarily humid atmosphere. Maintenance records indicate a total expenditure of $93.21 during the 16 years for service and parts, less than $6.00 a year. Because of the full flexible speed range and easy controllability of the Oilgear drives, the laminating machine is operated at speeds that best fit the type of board being processed and the cut-off drive follows in synchronism to cut stock into uniform lengths.

Another Oilgear feature important here is the unusual speed with which the laminating machine drive and cut-off drive can be started and stopped. This feature of Oilgear smooth, high speed acceleration and quick hydro-dynamic braking reduces non-productive time and cuts spoilage of sheets to a bare minimum.

On the basis of the 16 year performance of Oilgear, the Chicago Carton Company recently installed another Oilgear drive on a new 125 hp installation.

Time after time, Oilgear demonstrates its superiority and dependability on variable speed drives. Oilgear Fluid Power has many advantages. Investigate them now. THE OILGEAR COMPANY, 1570 W. Pierce St., Milwaukee 4, Wis.

UPPER—Oilgear 40 hp Variable Speed Drive with electric pilot motor remote control and oil reservoir base.

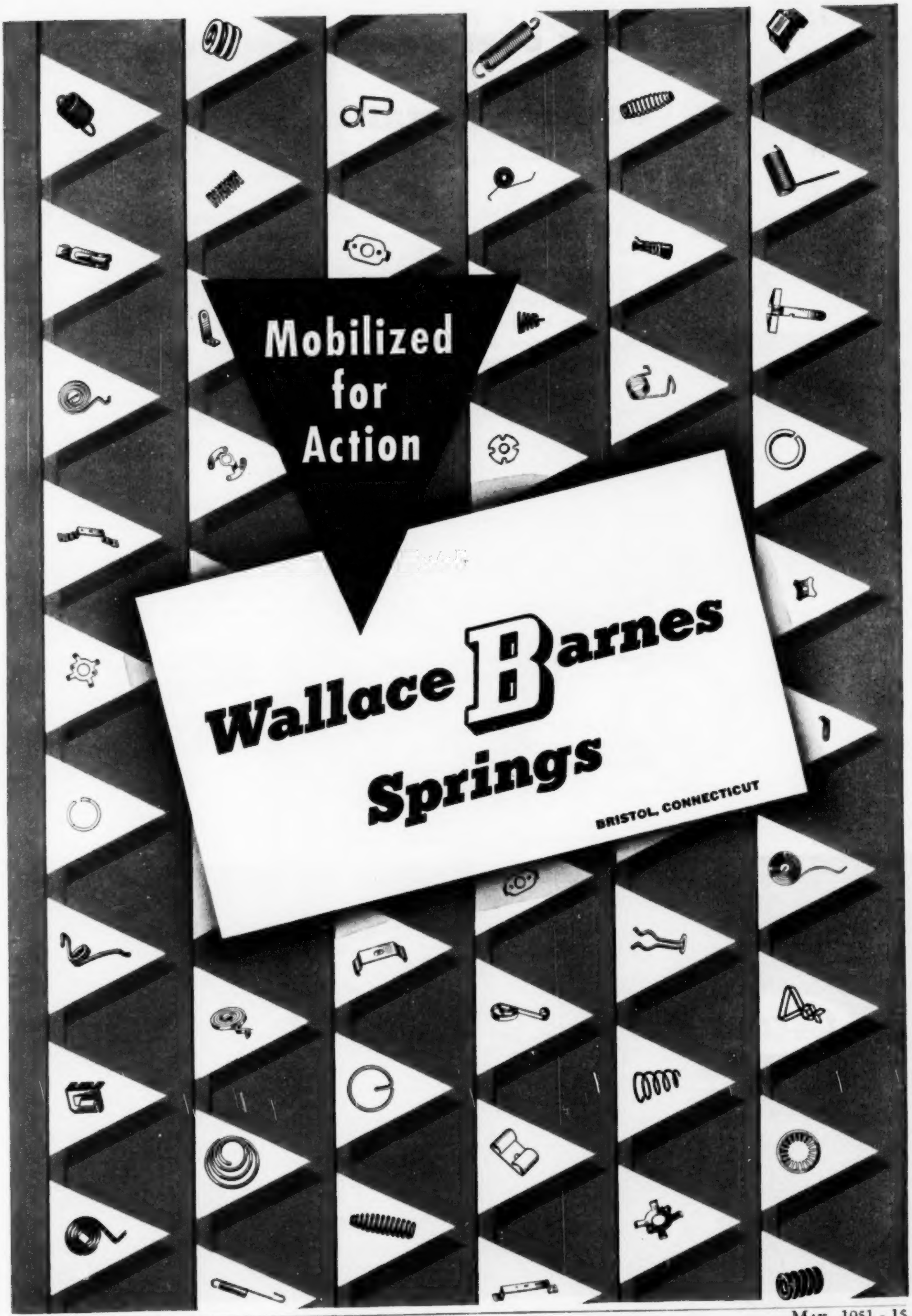
LOWER—Oilgear 7½ hp Variable Speed Drive with automatic control to synchronize cutter speed with speed of laminating machine drive.

Oilgear

PIONEERS IN FLUID POWER

PUMPS, TRANSMISSIONS, CYLINDERS AND VALVES

OILGEAR


Mobilized
for
Action
Wallace Barnes
Springs
BRISTOL, CONNECTICUT

New compressor design cuts refrigeration costs

The new Carrier 5-J Compressor represents the biggest improvement in reciprocating compressor design in years. Developed especially for commercial applications requiring from 75 to 200 horsepower in single units, the 5-J has already introduced many exclusive refrigeration economies.

The Carrier 5-J is highly efficient at both full and partial loads, giving lower brake horsepower per ton of refrigeration. This means you can now use one unit rather than several smaller compressors. You realize savings in piping, valve fittings and electrical wiring and control items.

Here are other unique design features of the new 5-J compressor which is setting new standards for low-cost, heavy-duty refrigeration.

Precision built parts and dynamically balanced crankshaft almost eliminate vibrations. Under most conditions, installation can be on upper floors.

Takes any type of drive. Can be powered by motor, gas or Diesel engine, or steam turbine with gear. May be operated as dual units from single motor with a double shaft.

Replaceable wearing parts. Every moving part subject to wear is easily and quickly replaced.

Vapor cushioned valves. Exclusive feature provides quiet operation and longer life.

Positive pressure lubrication. Built-in oversize pump forces oil under pressure to all moving parts.

Oil cooler and cleanable oil filter with by-pass cools and filters all oil to bearings.

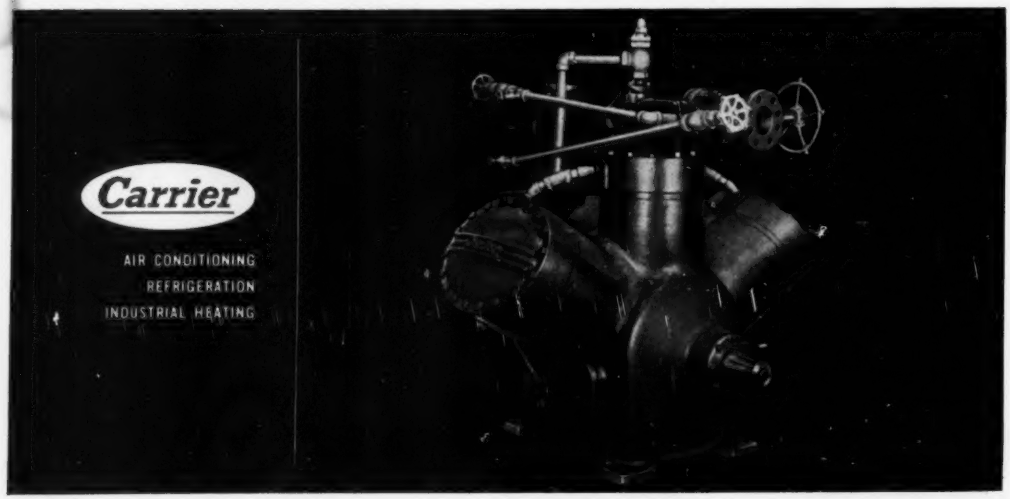
Water-jacketed cylinder heads minimize suction gas preheating and carbonization of oil on discharge valves.

Manual load leveler allows operator to vary compressor capacity in direct response to suction pressure. These controls can be made automatic.

Uses most refrigerants—Ammonia, "Freon-12," "Freon-22," "Carrene 7" and many others.

For more complete information about the new Carrier 5-J Compressor, call your Carrier representative or write for folder No. 5J20 to Carrier Corporation, Syracuse 1, N. Y.

Shown here is the new Carrier Ammonia Compressor.



IT ALWAYS PAYS TO SPECIFY

LADISH

Controlled Quality

PIPE FITTINGS

TO MARK PROGRESS

...you know they are in to stay

Long, trouble-free piping service results from extra safeguards in the manufacture of Ladish fittings. Rigid laboratory controls over chemical composition and physical properties of steel provide an assurance of maximum strength and resistance to erosion or corrosion. These are some of the extra safeguards for dependable operation which you always get in greatest measure in Ladish Controlled Quality Fittings.

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF... ONE RESPONSIBILITY

LADISH CO.

CUDAHY, WISCONSIN
MILWAUKEE SUBURB

District Offices: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago • St. Paul
St. Louis • Atlanta • Houston • Tulsa • Los Angeles • Havana • Toronto • Mexico City

MORSE DRIVE SHAFTS (in five series and three types)

TRANSMIT POWER

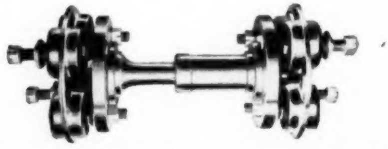
ECONOMICALLY RELIABLY WITHOUT LUBRICATION

Flexible Morse Drive Shafts provide a cushioned drive between separated units. They provide torsional flexibility, absorb shock, and isolate vibration while transmitting power noiselessly, dependably, safely, and economically. Four of the five series accommodate end float *and* provide full universal action.

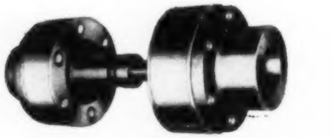
Look over the condensed descriptions of Morse Drive Shafts on this page. In addition to the standard sizes shown, special drive shafts can be made for unusual applications. Write us for more complete information.

MORSE CHAIN COMPANY
Dept. 153, 7601 Central Ave., Detroit 8, Michigan

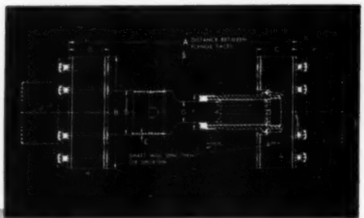
Series T—Solid or tubular depending on capacity. Ten assemblies ranging from 13 to 725 lbs.-ft. torque capacity. Inter-flange distance from $3\frac{1}{4}$" to 84". Misalignment compensation proportional to length of tube. HP capacity from .25 to 13.80 per 100 RPM.



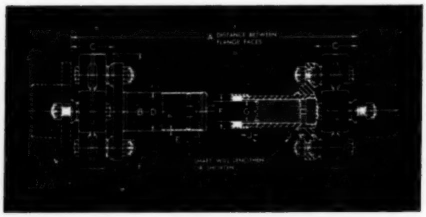
Series S—Grease-tight slip joint permits end float. Provides full universal action. Six assemblies ranging from 84 to 725 lbs.-ft. torque capacity. Inter-flange distance from $10\frac{5}{16}$" to $17\frac{1}{8}$". Maximum 5° angular misalignment compensation. HP capacity from 1.60 to 13.80 per 100 RPM.



Series RS (Radial Coupling Drive Shaft)—Provides end float plus added capacity. Five assemblies ranging from 158 to 2127 lbs.-ft. torque capacity. Inter-flange distance from $10\frac{5}{8}$" to $14\frac{5}{8}$". HP capacity from 3 to $40\frac{1}{2}$ per 100 RPM.



Series RT—Basically an RS Drive Shaft with tubular shaft welded to each end member to provide additional length. Five assemblies ranging from 158 to 2127 lbs.-ft. torque capacity. Inter-flange distance from $11\frac{1}{8}$" to 84". HP capacity from 3 to $40\frac{1}{2}$ per 100 RPM.



Series ST—Basically a Series S Drive Shaft, with tubular shaft welded between hub and yoke members to provide additional length. Six assemblies ranging from 84 to 725 lbs.-ft. torque capacity. Inter-flange distance from $11\frac{3}{16}$" to 84". Misalignment compensation proportional to length of tube. HP capacity from 1.60 to 13.80 per 100 RPM.

M=PT
Morse *means* Power Transmission

MORSE
MECHANICAL POWER TRANSMISSION PRODUCTS

PRODUCTS OF B-W BORG-WARNER

better measurement and control of
TEMPERATURE
FOXBORO
−350°F to +2800°F
Throughout the vast field of industrial temperature instrumentation, Foxboro will be found in the greatest number of installations where complete reliability and most economical fulfillment of optimum accuracy are vital. If your process requires temperature measurement or control in any range between −350°F. and +2800°F., the high engineering standards and complete diversity of Foxboro Instruments . . . backed by Foxboro's unequaled application experience . . . offer you the way to obtain it most effectively.
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For over 40 years, specialists in the measurement and control of temperature, pressure, flow, liquid level, humidity . . .
THE FOXBORO COMPANY • FOXBORO, MASSACHUSETTS, U.S.A.

Pep to Spare
▶ SPRINGS
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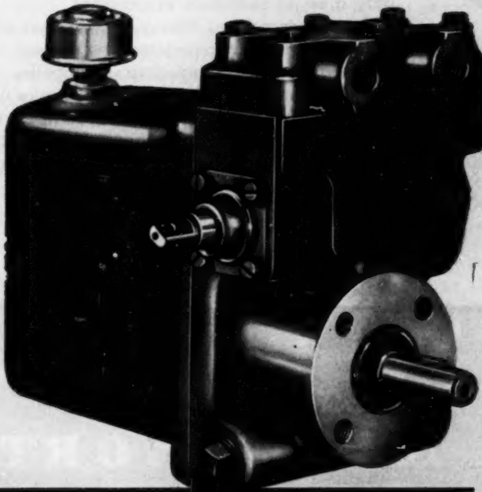
The Hydraulic "Package" of a THOUSAND USES

VICKERS POWER PACK



Simplifies Hydraulic Design

•

Saves Money, Space and Time

These three applications of the Vickers Power Pack indicate something of the extremely wide usage range of this hydraulic package.

Manufacturers have found it ideally suited to the largest variety of mobile as well as many stationary installations. It provides a compact, self-contained hydraulic system which is quickly and easily installed at low cost. Pump, relief valve, operating valves, oil tank and oil filter are all contained in the rugged, compact unit.

Vickers Power Pack is used on planters, cultivators, plows, stackers, loaders, harvesters, rakes, mowers, dump hoists, lifting tailgates, light duty scrapers, fork lift trucks, loaders, scoops, snow plows, etc. Check into its advantages for your accessory power source.

WRITE FOR BULLETIN 46-48

VICKERS Incorporated

DIVISION OF THE SPERRY CORPORATION

1500 OAKMAN BLVD. • DETROIT 32, MICH.

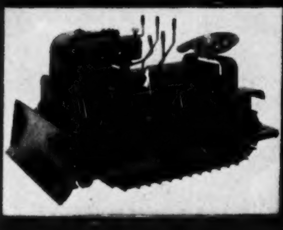
Application Engineering Offices: ATLANTA • CHICAGO • CINCINNATI CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan) NEW YORK (Metropolitan) • PHILADELPHIA • PITTSBURGH • ROCHESTER ROCKFORD • ST. LOUIS • SEATTLE • TULSA • WASHINGTON • WORCESTER

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

4434

OLIVER COMBINE

Vickers Hydraulic Power Pack provides fingertip, instant control of the twin cylinder harvester control.



WILLCO J-7 CRAWLER TRACTOR

This powerful little general purpose tractor uses Vickers Hydraulic Power Pack for fingertip control of bulldozer blade (46" wide x 18" deep) and other attachments.

BEACON DOCK RAMP

Vickers Hydraulic Power Pack powers vertical movement (24") to level with truck or freight car floors . . . also horizontal movement (14") where outer doors must seal when board not in use.

WHEN A PUMP MUST HANDLE
Widely Varying Heads

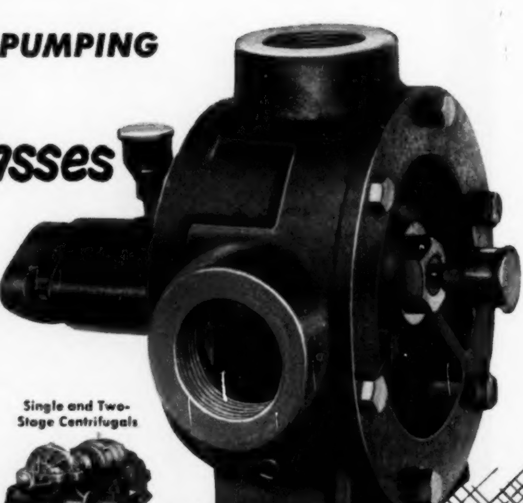
. . . the efficient, economical choice is a dependable Fairbanks-Morse Westco turbine type pump. These rugged, precision-built pumps are designed so that maximum capacity is obtained at an operating speed of 1750 r.p.m. when discharging at low pressure. High pressures are developed at the same speed with only a slight reduction in capacity.

Another important Westco advantage: you get multi-stage pump performance through the use of a single stage multi-vaned impeller.

These important Westco features make it a top choice where the pump must form an integral part of machines, units or systems. It is exceptionally compact. Capacities range from 1 to 200 g.p.m., with heads ranging up to 500 feet.

FAIRBANKS
A NAME WORTH

WHEN YOU NEED POSITIVE PUMPING OF ANY LIQUID
from Gasoline to Molasses



. . . the choice is Fairbanks-Morse Rotary Pumps. These positive displacement pumps efficiently handle any free-flowing liquid. Their exceptionally high efficiency, steady flow, freedom from vibration and non-fluctuating load characteristics assure long, economical service.

With only two moving parts, there are no complicated adjustment or service problems. Capacities range from 1.3 to 450 g.p.m.

Other Fairbanks-Morse Pumps Include:

Builtogether Centrifugals

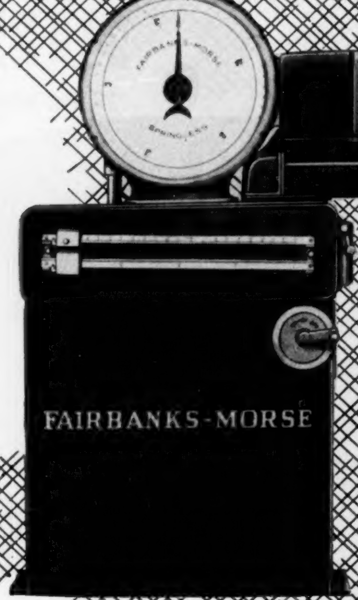
Side-Suction Centrifugals

Single and Two-Stage Centrifugals

WHEN A SCALE MUST DO *More than Weigh*

. . . then Fairbanks-Morse Printomatic Weighers are your answer. In addition to automatically recording weights on a ticket or tape, these weighing instruments can, through the use of electronics, automatically control production and processing operations. They can be adapted for automatic control of batching processes, materials handling, and conveying systems. They can open and close gates or valves, controlling flow of material to predetermined quantities. Templets can be used to preserve formula secrets when compounding mixes.

Fairbanks-Morse Printomatic Weighers speed operations. They eliminate the chance for human errors . . . eliminate inefficiencies and losses caused by inaccuracies. Your Fairbanks-Morse weighing expert will be happy to help you fit a Printomatic to your operations.

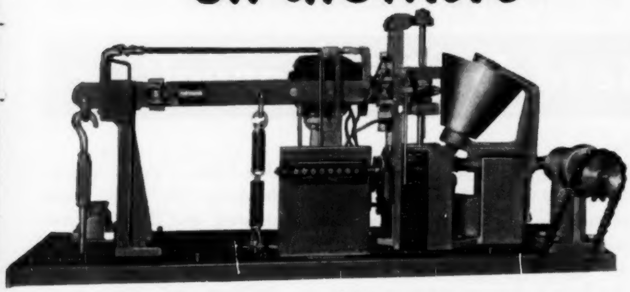


Printomatic Weigher

-MORSE

REMEMBERING

WHEN YOU MUST WEIGH *"On the Move"*

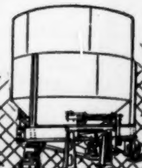


Belt Conveyor Scale

. . . check Fairbanks-Morse Belt Conveyor Scales. These efficient, accurate weighing instruments automatically weigh material in transit . . . provide cumulative totals up to 1500 tons per hour. Installed as an integral part of the conveyor system, Fairbanks-Morse Belt Conveyor Scales speed weighing of incoming raw bulk materials and materials in process.

Whatever your weighing requirement, there is a Fairbanks-Morse lastingly accurate scale that exactly suits your needs. Fairbanks-Morse Scales or *component scale parts* can be supplied to fit right into your equipment for weight or control operations.

Hopper Scale



See next page for Fairbanks-Morse Sales Centers

FOR PROTECTION

AGAINST DUST, DIRT, ABRASIVES, STEAM, FUMES, ETC.

FAIRBANKS-MORSE

Totally Enclosed, Non-Ventilated Motors

For the toughest operating conditions, here is the newest development in totally enclosed, non-ventilated motors. Fairbanks-Morse Type QZE Motors are now available in Frame 284—delivering 7½ hp. at 1800 r.p.m., 5 hp. at 1200 r.p.m—filling a long-standing need for this type and size of motor. New features that assure cool, long-running service include a unique end-bell construction with cooling fins for efficient heat dissipation — and for safe, uniform, internal temperatures. For the full story on the new dependability this class of QZE Motors can bring to your most severe motor jobs, ask your Fairbanks-Morse motor representative or write Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago 5, Illinois.

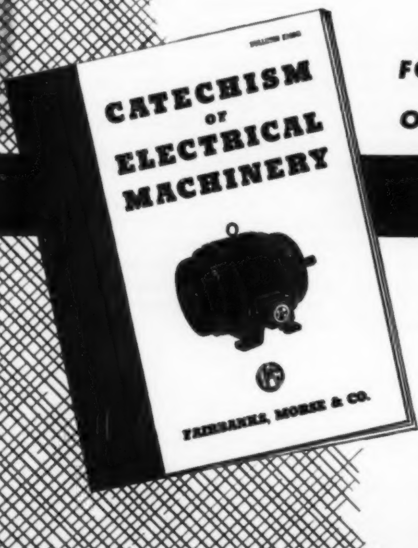
New Fairbanks-Morse Type QZE, Frame 284 Motor. Also available in smaller frame sizes.

FAIRBANKS

A NAME WORTH

FOR INFORMATION

ON DESIGN AND USE OF ELECTRIC MOTORS



Send for This Manual!

In this popular "Catechism of Electrical Machinery," you'll find an invaluable fund of basic information on the design, performance and proper use of the common types of alternating and direct current motors and generators. Primarily intended for training those who are not too familiar with electrical phenomena or terminology, it has been widely accepted by engineers, designers, and others as an aid in instruction of new men. It can be especially useful now, during this period of expanding and shifting employee rolls. Write your nearest Fairbanks-Morse Sales Center for your copy.

FOR SATISFACTION
IN SERVICES THAT ARE ROUGH ON MOTORS!

Compare these features

Superior Electrical and Mechanical Construction In All Fairbanks-Morse Type QZE Motors

Completely Protected Windings — No ventilating openings: impossible for any foreign matter to come in contact with windings.

Easy to install — NEMA standard mountings, interchangeable with standard, open-type motors of same ratings.

Grease lubricated ball bearings — permit sealing for the life of the bearing if desired.

Heat transfer air circulation — continuous circulation of captive air inside frame structure assured by rotor fans.

Convenient lubrication — protective covers or other parts need not be removed.

Reversible recessed conduit box — symmetrical construction allows easy reversal of stator frame.

COPPERSPUN ROTOR an Added Advantage

All Fairbanks-Morse Type QZE totally enclosed, non-ventilated motors offer the Fairbanks-Morse Copperspun rotor whose one-piece, virtually indestructible design and excellent electrical characteristics assure longer, more trouble-free life.

-MORSE
REMEMBERING

THESE ARE YOUR FAIRBANKS-MORSE SALES CENTERS

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GAspee 1-1531

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CHestnut 7483

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OILITE may relieve your shortage of critical materials

Particularly in mass-production units of small and medium size, Oilite finished machine parts and bearings can be made to your design in a broad range of ferrous and nonferrous metals and alloys, except as limited by government control. Moreover, Oilite products of ferrous base may serve excellently instead of scarce nonferrous units or as replacements for steel and castings.

When you employ Oilite you also obtain the benefits of more than 20 years' engineering, research, and production experience in powder metallurgy, together with the service of field engineers throughout the United States and Canada.

You are invited to contact the field engineer in your district or write the home office regarding the application to your needs of Oilite products.

AMPLEX MANUFACTURING COMPANY

Subsidiary of Chrysler Corporation

DETROIT 31, MICHIGAN

Field Engineers and Supply Depots in Principal U. S. and Canadian Cities

OILITE PRODUCTS

Heavy duty, oil-cushioned, self-lubricating bearings and finished machine parts in ferrous and nonferrous metals and alloys. Permanent filters. Friction units. Self-lubricating cored and bar stock.

A Note to Executives

Oilite is an effective replacement, not a mere substitute

In the last decade, more and more executives have become "Oilite minded" because the advantages are many. To meet the current situation, many of our customers have changed their specifications to replace strategic copper and tin with products of iron powder or iron powder alloys. Others are replacing iron castings, steel and aluminum with similar Oilite products.

Also of importance to executives, under conditions of urgency, are the wide adaptability, the speed of delivery, and the economy of cost, time and manpower which result from the use of Oilite finished machine parts, made from metal powders.

Intricate designs, which normally require many different machining operations, can be produced quickly and economically from Oilite. There is great freedom of design and frequently two or more parts can be combined in a single Oilite unit. Oilite eliminates up to 24 machining operations.

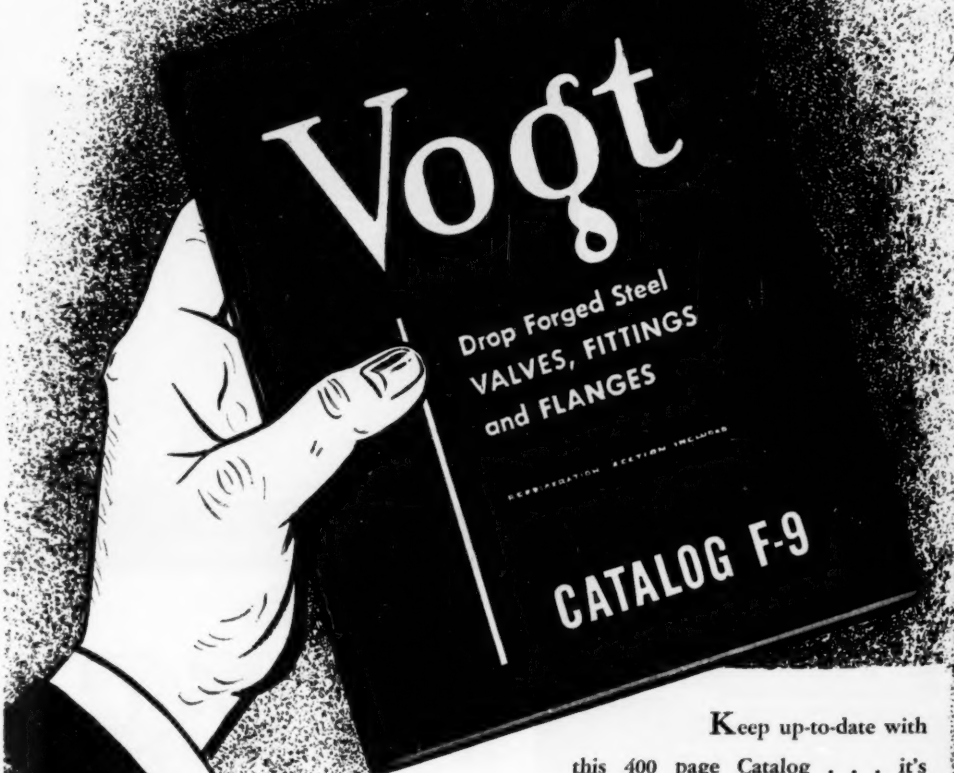
Delivered ready for assembly, Oilite parts save the time and investment required to tool up by standard methods. It is not unusual to be in production on a complex Oilite part within a few weeks, as compared to a possible 18-month delivery of machine tools. Trained manpower is thus released for other urgent needs.

Oilite is not a substitute. It is metallurgy's answer to the need for a new material. It may solve your problem.

President

OILITE PRODUCTS

it's NEW!

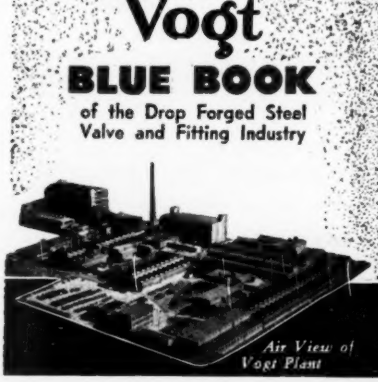


Keep up-to-date with this 400 page Catalog . . . it's chock full of new and improved *drop forged steel* Valves, Fittings and Flanges designed to meet every modern piping need for high or low pressures and temperatures in process work.

Be Safe and Sure . . . Use Vogt *drop forged* in all oil, water, steam, air, gas and refrigeration services.

Write for a copy of Catalog F-9
on your Company letterhead

Vogt
BLUE BOOK
of the Drop Forged Steel Valve and Fitting Industry



Air View of Vogt Plant

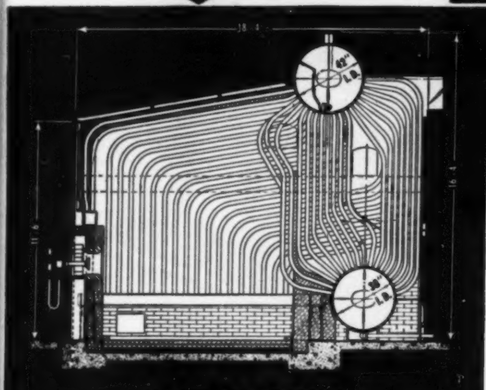
HENRY VOGT MACHINE CO., Inc.,
LOUISVILLE 10, KENTUCKY
BRANCH OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va.

WHICH V-C Meets Your Needs?

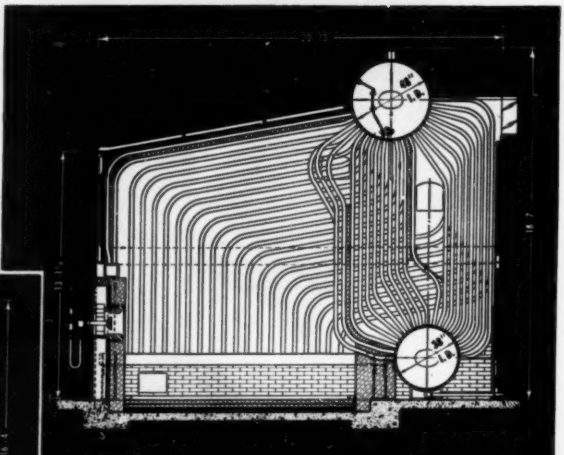
Both are High Capacity 2-Drum Water Tube Boiler Units for Limited Space....

3 V-C

This series with 42" top drum—17 tubes deep thru the main boiler bank, has integral water cooling in front, sides and top. A selection of 17 standard sizes available in widths from 5'-2" to 17'-2" and heating surfaces from 1394 to 5426 square feet.



OIL or GAS FIRING



OIL or GAS FIRING

4 V-C

This series with 48" top drum—19 tubes deep thru the main boiler bank—has integral water cooling in front, sides and top. A selection of 17 standard sizes available in overall widths from 5'-2" to 17'-2" and heating surfaces from 1850 to 7245 square feet.

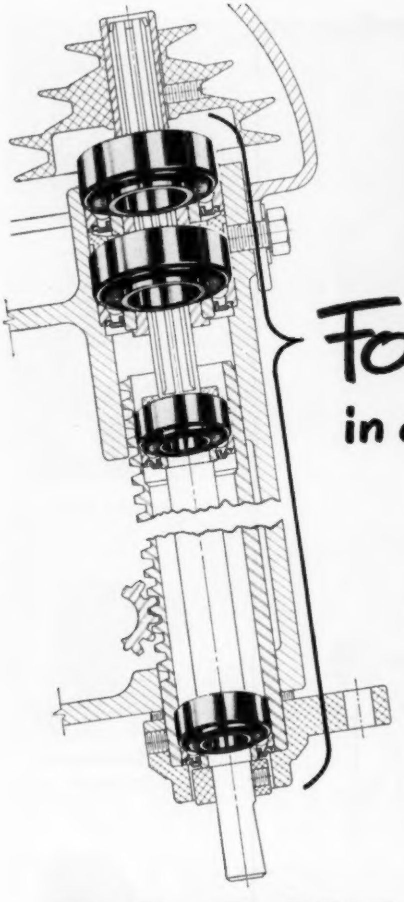
WRITE for Erie City Bulletin SB37A containing complete engineering data for Types 3 V-C and 4 V-C 2-Drum water tube boilers for spreader stoker, underfeed stoker and oil or gas firing. Investigate this steel cased, completely water cooled steam generator which incorporates modern ideas in a compactly designed high efficiency unit.

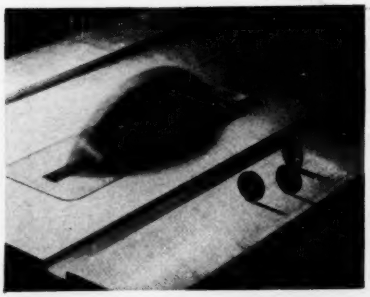
COMPLETE STEAM POWER PLANT EQUIPMENT

ERIE CITY

Complete Steam Generators • Type C 3-Drum Boilers • Types VL & VC 2-Drum Boilers • "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • "Keystone" Packaged Steam Generators • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

ERIE CITY IRON WORKS • ERIE, PA. • Since 1840





FOUR star performers
in a "ONE TOOL WORKSHOP"

Here's visual evidence of the Star Performers' worth to the SHOPSMITH . . . an amazingly accurate, versatile, low-priced electric power tool for hobbyists, maintenance departments, and small businesses. With saw blade at full speed, coins stand on edge . . . a tribute not only to the precision construction of the machine, but to the performance of Fafnir Ball Bearings.

Since the SHOPSMITH operates in both vertical and horizontal position and under so many different conditions, the Fafnir head-stock ball bearings are an extremely important factor to successful operation.

Putting accuracy into inexpensive equipment is a problem that Fafnir has solved successfully on many occasions. That's because Fafnir's experience is not limited to just one or two industries but is industry wide. The Fafnir Bearing Company, New Britain, Conn.

BEARINGS SHOWN

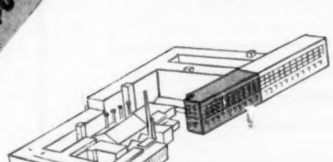
The Shopsmith spindle floats on four Fafnir pre-lubricated Mechani-Seal Type Ball Bearings. Two support the spindle in the quill, and two support the internally splined drive shaft.

FAFNIR
BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

★ PROGRESS REPORT

NEW PLANT ADDITION!



Part of a long range expansion program . . . the recently completed, 6-story modern building located at the main Fafnir Plant comes at an opportune time. It adds 70,000 square feet of manufacturing space to the 750,000 previously occupied by 3 Fafnir plants . . . now, almost 19 acres.

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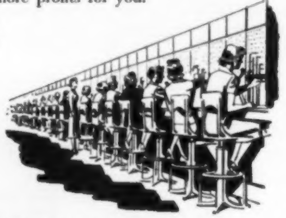
Miami, too, has a conveniently located American Blower Branch Office to provide you with data and equipment for air handling. You can reach American Blower in Miami by calling 7-4968. In other cities, consult your phone book.

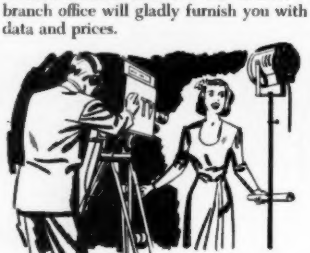
TICKETS PLEASE...

Whether it's theaters, auditoriums, or sports arenas, you can count on American Blower Air Handling Equipment to keep your customers comfortably cool. The combination of American Blower fans and air washers, for example, forms a complete, compact method of comfort cooling large areas at low cost. The fan provides a supply of circulating outdoor air. The air washer cleanses, purifies and freshens the air while removing dust and water soluble odors. End result —a healthy volume of repeat business, more profits for you.



NUMBER PLEASE...

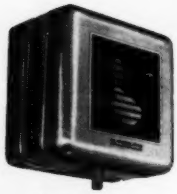
"Pleasant working conditions" is high on the list of reasons why people like to work for the telephone company. We're proud that many telephone buildings and exchanges around the country use American Blower air conditioning and ventilating equipment to create a fresh atmosphere indoors. They've found, as have many other businesses, that American Blower products provide not only high operating efficiency at low cost but their styling blends well with modern business interiors. Our nearest branch office will gladly furnish you with data and prices.



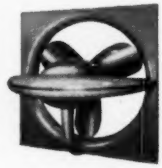
QUIET PLEASE...

Hot lights, plenty of activity and nervous tension call for good ventilation in radio and TV studios. Yet fans must operate quietly to prevent "mike" pickup. The quiet operating feature of American Blower fans makes them ideally suited for jobs like this. American Blower Sirocco Fans, for example, deliver more air per revolution than any other type fan, operate at lower tip speeds (making them unusually quiet), and save power.

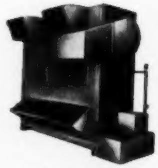
MAY WE SERVE YOU?
American Blower heating, cooling, drying, air conditioning and air handling equipment can do much toward improving comfort and efficiency in your business. For data, phone or write our nearest branch office.



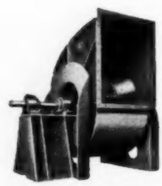
Unit Heaters



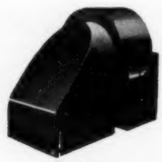
Ventura Fans



Air Conditioning Equipment



Industrial Fans



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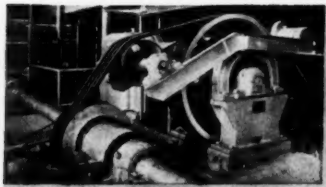
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

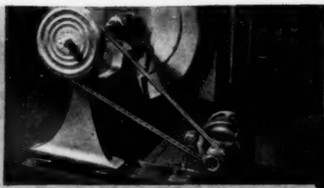
Division of American Radiator & Standard Sanitary corporation

YOUR BEST BUY AMERICAN BLOWER AIR HANDLING EQUIPMENT

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS • DETROIT LUBRICATOR • KEWANEE BOILERS • ROSS HEATER • TONAWANDA IRON



Paper Making Machine—Motion Control *Vari-Pitch* drive synchronizes paper machine sections.

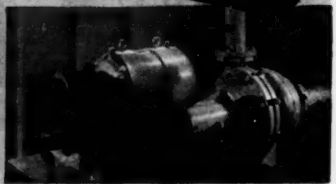


Air Conditioning unit — Stationary Control *Vari-Pitch* drive provides for seasonal adjustments.

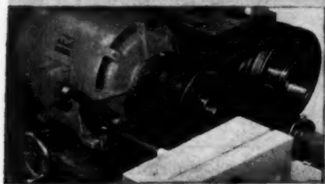
TEXROPE Drives for Speed Control

Cigarette Making Machine — Stationary Control *Vari-Pitch* drive provides for infrequent speed changes.

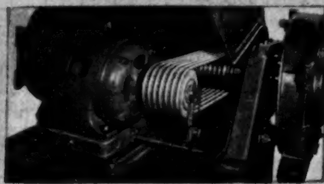
Pipe Threading Machine—Automatic *Vari-Pitch* drive gives simple, stepless handwheel speed changes.



Solids Handling Pumps—Double Motion-Control *Vari-Pitch* drive provides extra wide speed range.



Automatic lathe — Automatic *Vari-Pitch* sheave gives stepless speed changes for making ultra-fine finish.



Grinder—Motion Control *Vari-Pitch* drive holds cutting speed constant as diameter of wheel wears.

Conveyor — *Vari-Pitch* Speed Changer raises or lowers speed to meet production requirements.

HOW USERS PROFIT

With *Texrope* Adjustable Speed Drives

TAKE A TIP from these users. Get the speed you need for peak efficiency by adding *Texrope* variable speed drives. Best of all, no elaborate equipment — no special costly motors are required.

You'll increase efficiency . . . get maximum output when you adjust speed to meet variations in: the part processed; tooling; machine loading; and temperature and humidity.

There's a type or size *Texrope* adjustable speed drive to fit any requirement. Whether you need to change speeds rarely or frequently — when the machine is shut down, or when it's running — whether you're using one horsepower or 50, Allis-Chalmers can supply you.

In addition, Allis-Chalmers offers you more than the drive itself. A-C offers the extra engineering skill that naturally results from having more industrial V-belt installations than any other manufacturer. This in itself is important.

Get section 20P50 for complete engineering information on *Vari-Pitch* sheaves from your A-C Authorized Dealer or Sales Office, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

Choose from These Types of Variable Speed Drives

VARI-PITCH SHEAVES for A-B, B, C, D, and E belts — speed variation 15% to 25% per sheave. Capacities 1 to 125 hp. Stationary type — for changing speed when motor is stopped. Motion Control type—for changing speed when motor is running.

WIDE RANGE VARI-PITCH SHEAVES for Q or R wide belts provide up to 2 to 1 speed range . . . fractional to 40 hp. Available in Stationary Control and Automatic types.

VARI-PITCH SPEED CHANGER — enclosed unit for adjusting speed while machine is in motion. Provides up to 3.75 to 1 speed range. Capacities 1 to 75 hp.

A-3262

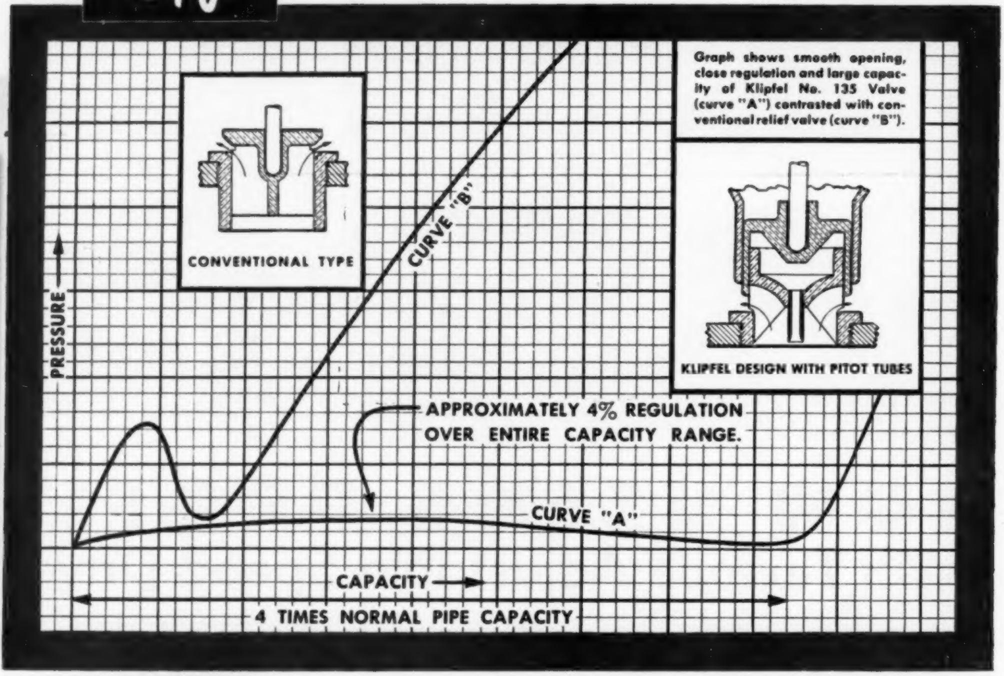
Texrope and Vari-Pitch are Allis-Chalmers trademarks.

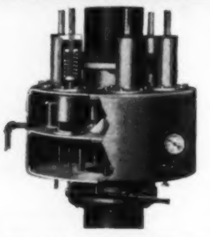
ALLIS-CHALMERS

A-C

Using relief valves?

CHECK THE PERFORMANCE OF **Klipfel** NO. 135 SINGLE and MULTIPORT VALVES





PERFORMANCE CHARACTERISTICS

Compensated Spring Loading—
by using fluid velocity.

Tight Closing—
with thin edged seat for low venturi effect.

Chatter-proof Operation—
though inherent dash-pot construction.

Multiport Valves—
open in sequence minimizing wire drawing and improving regulation. Positive testing of each valve with external handle.

Single or multiport, the Klipfel No. 135 maintains steam back pressure accurately. Among the features which have made it a favorite with operating and maintenance men are:

INNER VALVE—*an inverted cup slides smoothly on a piston which is integral with the threaded seat bushing.*
EXTERNAL SLEEVE—*an extra feature—permits close regulation with variable outlet pressure by venting spring chamber to a constant pressure source.*
SPRING—*extra long with low spring scale.*
BODY—*in single port, bronze, semi-steel or steel casting. In multiport, all-welded steel plate body.*
PRESSURE RANGE—*single port, up to 300 P.S.I.G.; multiport, vacuum to 20 P.S.I.G.*

FOR FULL DATA on the Klipfel No. 135, write Dept. CM-5

Klipfel VALVES INC.
DIVISION OF HAMILTON-THOMAS CORP.
HAMILTON, OHIO

Introducing "Formbrite"

Specially processed copper alloys with a money-saving grain structure

Formbrite is a metallurgical development of The American Brass Company applied to copper alloys, particularly brass. A special rolling or drawing process plus a special heat treatment impart a superfine grain structure to the metal.

Because of its fine grain and hard surface, substantial economies can be effected in polishing and finishing. Usually only a simple color buff is required before plating.

As a drawing brass in the form of sheet or strip, Formbrite is stronger, harder and more resistant to scratching and abrasion—yet so ductile that it readily withstands deep-drawing operations.

In the form of rod and wire, Formbrite has about the same strength as regular cold heading wire—with good ductility. It is ideal for rivets, wood and machine screws and upset products generally. A minimum tumble cleans and polishes Formbrite fastenings.

Formbrite is beyond the experimental stage. Millions of pounds have been made, sold and satisfactorily fabricated and finished. It costs no more than standard drawing or cold heading brass. If you are cold-working brass in the form of sheet, strip or wire, you will want to know more about Formbrite. Write for Publication B-39 . . . and if you'd like to compare Formbrite with ordinary drawing brass in your own polishing room, ask for the kit of two sample cups. The American Brass Company, General Offices, Waterbury 20, Conn.

5190

Formbrite is a trademark of The American Brass Company designating copper-base alloys of exceptionally fine grain, combining unusual polishing characteristics with good strength and hardness, plus excellent ductility.

ANACONDA

the name to remember in

COPPER·BRASS·BRONZE

DUCTILE IRON

A Revolutionary Metallurgical Development

DUCTILE IRON is a cast ferrous product which combines the *process advantages* of cast iron with many of the *product advantages* of cast steel.

No longer in the pilot-plant stage, this new material is now produced and sold on the basis of specifications. Not only are its individual properties exceptional, but no other common engineering material provides such a combination of excellent castability and fluidity, with high strength, toughness, wear resistance, and machinability.

Actually, "ductile iron" denotes not a *single* product, but rather a family of ferrous materials characterized by graphite in the form of spheroids . . . a form controlled, in a broad sense, by small amounts of magnesium. Presence of spheroidal rather than flake graphite gives this new product a ductility that is unique among gray cast irons.

Four important types of ductile iron now being produced commercially are tabulated below.

REPRESENTATIVE MECHANICAL PROPERTIES OF COMMERCIAL HEATS OF DUCTILE IRON

	Grade	Tensile strength, psi	Yield strength, psi	Elongation per cent	BHN	Usual condition
A	90-65-02	95/105000	70/75000	2.5/5.5	225/265	As-cast
B	80-60-05	85/95000	65/70000	5.5/10.0	195/225	As-cast
C	60-45-15	65/75000	50/60000	17.0/23.0	140/180	Annealed
D	80-60-00	85/95000	65/75000	1.0/3.0	230/290	As-cast

A Pearlitic in structure. Provides good mechanical wear resistance.

B Pearlitic-ferritic in structure. Provides strength and toughness combined.

C A fully ferritic structure usually obtained by short anneal of either (A) or (B). Provides optimum machinability and maximum toughness.

D Higher phosphorous content than preceding grades, also higher manganese. Provides high strength and stiffness, but only moderate impact strength.

SOME UNIQUE PROPERTIES OF DUCTILE IRON

1. Its elastic modulus, about 25,000,000 psi, is virtually unaffected by composition or thickness . . .

2. It can provide a chilled, carbidic, abrasion-resistant surface supported by a tough ductile core. No other single material can combine these properties . . . its only counterpart being a tough material coated with a hard welded overlay.

3. As-cast ductile iron of 93,000 psi tensile strength has the same machinability rating as gray iron with a strength of 45,000 psi.

4. Annealed ductile iron can be machined at a rate 2 to 3 times that of good quality gray iron.

5. It can be satisfactorily welded.

APPLICATIONS

Automotive, agricultural implement, railroad and allied industries apply ductile iron, as-cast and heat treated, in components too numerous to detail.

Machinery, machine tools, crankshafts, pumps, compressors, valves and heavy industrial equipment such as rolls and rolling mill housings, utilize its high strength and rigidity.

In scores of engine, furnace and other parts serving at elevated temperatures, it provides oxidation and growth resistance heretofore unavailable in high carbon castings.

Other applications include paper, textile and electrical machinery, marine equipment, and pipe.

AVAILABILITY

Send us details of your prospective uses, so that we may offer a list of sources from some 100 authorized foundries now producing ductile cast iron under patent licenses. Request a list of available publications on ductile iron . . . mail the coupon now.

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 73 — NUMBER 5

Contents for May, 1951

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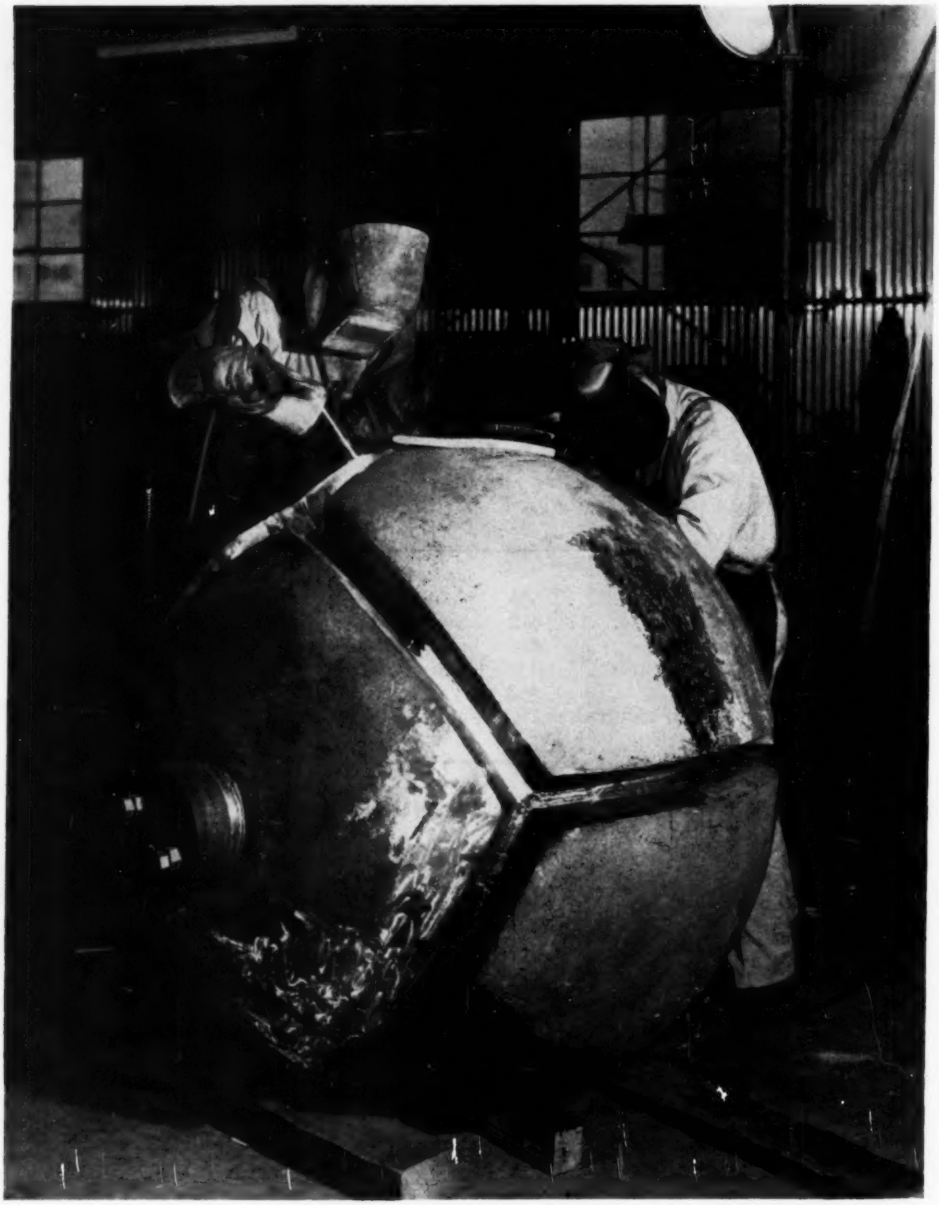

Courtesy Northrup Aircraft, Inc

The Nitro-Sphere, a New Welded Stainless-Steel High-Strength Pressure Vessel

(*Shown during process of arc welding, this spherical storage chamber, for use by the U. S. Air Force in rocket-propelled aircraft experiments, is stressed to contain 200 gal of liquid nitrogen at 5500 psi and minus 340 F with a comfortable safety tolerance.* *For further details see page 415.*)

Volume 73
No. 5

MECHANICAL ENGINEERING

May
1951

GEORGE A. STETSON, *Editor*

To the Graduating Class

IT IS up to each one of you who is a member of the graduating class and a Student Member of The American Society of Mechanical Engineers to decide whether or not you will apply for transfer to the Junior grade, and thus continue unbroken your professional society affiliation, or fail to do so and thereby interrupt or cut off a relationship with your fellow engineers that will become more valuable to you as the years roll by.

The decision you make is important to you, to the profession with which you have identified yourself, and to your country. It is complicated by the conditions which the nation faces today and particularly by extraordinary conditions which many of you are facing up to. Your country needs you; the engineering profession and industry need you; your families need you; and each of you has his own hopes, ambitions, and plans for the future that clamor for fulfillment. If you live in an era when extraordinary uncertainties appear to confront your plans for the future, remember that the principal difference lies in the fact that you are acutely conscious of these uncertainties and even of the nature of many of them. Hence you can take account of them in your plan. It is failure to consider the probability of uncertainty that plays havoc with our lives when our plans go awry.

It is reasonable for each one of you to assume that in the long run you will be engaged in the profession for which your studies have been preparing you, regardless of what may develop in the immediate future. Whether you engage in engineering work immediately after graduation or some years hence, your contact with the profession by means of membership in an engineering society should not and need not be interrupted. So if you have not made arrangements to transfer your Student membership to the Junior grade, ask your faculty adviser how to do it.

ASME Junior Committee

APPROXIMATELY fifty per cent of the members of The American Society of Mechanical Engineers are in the Junior grade of membership. Into this great reservoir of engineering manpower flow the graduates of engineering colleges, and out of it men of maturity, experience, and achievement are advanced to the Member grade. Familiar as this pattern now is, it was not always so. For scarcely twenty years has the Society given serious consideration to the problems and needs of their younger members. And it was only a few years ago that the Junior Committee was formed.

The ASME Junior Committee, under the chairmanship of D. E. Jahncke, has made substantial progress since its organization in 1947. The Secretary of ASME and other members of the Secretary's office meet regularly with this committee. A Senior Adviser also serves on the Committee. At a recent meeting the Committee stated that its place in the Society was "to present the Juniors' views, insure that they are heard, and to obtain and hold active members for the Society."

Presentation of Junior opinion is accomplished by the Junior "observers" who serve on many of the important standing committees of the Society. This service has resulted in greatly stimulating the interest in professional and Society affairs taken by the young men, many of whom are today leaders in major Society and industrial activities.

Several years ago the Committee initiated a department in the ASME News section of this magazine, known as the "Junior Forum," in which it has been able to spread to all members of the Society reports of the activities of the juniors, letters, and brief articles by the juniors themselves in which an opportunity is provided for exchange of opinion and items of interest to the younger members. The Committee has been successful in obtaining the support of the "Old Guard," ASME members on a dues-exempt basis because of thirty-five or more years as dues-paying members. The Committee has also engaged in an active campaign to encourage participation by Juniors in the sections of the Society and in organized Junior Groups that have been established in some of the larger sections.

With this excellent start, the Committee is now looking ahead to an enlarged program of activities. It is hoped that the Juniors may become effective in letting Student Members know about their activities and about the Society and its work. Already the Philadelphia Junior Group has a committee for this purpose. As pointed out in a recent report of the Junior Committee in reference to the Philadelphia Section, "One Junior accepts the responsibility of seeing to one school. He attends its meetings, invites other Juniors to attend meetings, arranges the annual Student Night where a senior (Section member) sponsors a student for dinner, and in general becomes acquainted with the student group." As a result of this Junior activity, 100 per cent of the Student Members in that area have become Junior Members upon graduation.

Promotional and public-relations activities to convince employers of engineers of the value of ASME are also

being considered by the Junior Committee as part of its enlarged program. The report referred to states: "By repeated emphasis of the recognition of the engineer as the keystone of our industrial machine and that only through an engineering approach can efficiency, production, and economy be achieved, the ASME can instill in the minds of company management the thought that its engineers should be encouraged to participate in Society affairs."

Another project which the Junior Committee has under consideration is to increase the attendance of Junior representatives of the sections at national and regional meetings of the Society. The Old Guard has already assisted financially in this project, but it is hoped that more Junior representatives may attend these meetings, either at their own expense or at the expense of their employers. The Committee hopes to be influential in persuading companies to help in making it financially possible for their younger engineers to take advantage of this form of professional-society activity.

More Junior speakers at Junior-sponsored sessions of national and other Society meetings is another project which the Junior Committee hopes to promote. A considerable number of Junior Members already contribute papers to technical sessions of the Society. The expanded activity would afford opportunity for able young men to present their views on such subjects as the professional standing of engineers, what they expect of the Society, professional development, and various approaches to engineering production, efficiency, and method.

The Junior Committee visualizes its task as being that of "selling ASME." As the report states: "The Society must be sold first to the student and then to the junior engineer. Engineering as a profession must also be sold to management and the public."

ASME is fortunate in having an intelligent and aggressive body of young engineers who are willing to take their destinies in their own hands and work for their collective and individual betterment. It is this youthful fellowship that the Student Member is invited to join by transfer to Junior membership upon graduation.

Aids to Young Men

THE critical shortage of engineers which the profession and industry face during the next decade has stimulated all programs in being and in prospect that tend to develop as quickly and as richly as possible the technical and professional competence of graduate engineers. Engineering societies, employers, educational institutions, and industrial communities are faced with a very real necessity of avoiding waste in engineering manpower and in rapid and thorough development of engineering graduates into mature, competent, and resourceful engineers. Demands for military manpower make the current situation more acute because of drains put on a pool of young men already in short supply because of the low birth rate of the 1930's. Fortunately, both the engineering societies and many employers are conscious of this grave situation. Through their efforts an increasing number of aids to young men are now being developed.

Last fall the Engineers Joint Council set up its Engineering Manpower Commission. Meeting monthly and now staffed with a full-time executive secretary, the Commission is distributing to some 25,000 high-school principals, and to equal numbers of high-school teachers of science and mathematics, a pamphlet which calls attention to the shortage of engineers and to opportunities for young men in this important profession. The Commission is also working aggressively with other groups in keeping Selective Service and the Department of National Defense posted on this critical shortage and in urging clarification of procedures for the deferment of young men vitally needed by industry and for the calling of reservists. Because the Commission is made up principally of consultants and engineers in industry, its point of view has the authority of experience, competence, and intimate knowledge of current and future manpower needs.

Another aid to young men in which industry and educational institutions are co-operating is to be found in the program of the Engineers' Council for Professional Development which is designed to assist graduate engineers make the most fruitful use of the first five years after graduation. This program is directed toward the extension of opportunities for young engineers to continue their education while undergoing their internship in engineering practice, toward the establishment of more and better training courses offered by employers, toward an integration of engineering graduates into the civic, social, and religious life of the communities in which they are working, and toward their preparation for registration as professional engineers under the laws of the states in which they live.

The aid which industrial concerns are giving to engineering graduates individually is evidenced by their support of the ECPD program and collectively by their encouragement of participation in engineering-society activities. Such aid is growing more effective every year. Typical of the policy of many well-managed companies which employ engineers is the following:

"Active participation in engineering societies by every qualified employee should be encouraged; such participation should be regarded as part of the man's normal and regular work.

"A good engineering-development job is not finished until the noteworthy engineering uncovered has been presented at the proper time before a national technical society, and the pioneering knowledge of the company is made part of the permanent engineering literature.

"Membership in at least one engineering society is a definite responsibility of any company employee who regards himself as a member of the engineering profession."

With so many aids to young men becoming available, the Student Member of ASME should find plenty of encouragement in transferring his membership to the Junior grade.

FIG. 1 ATLANTIC REFINING COMPANY TANK STEAMSHIP "ATLANTIC SEAMAN"

S. S. "ATLANTIC SEAMAN"

The Engineering of a 30,000-Ton Supertanker—The First Ship Using 1020 F Steam

By LESTER M. GOLDSMITH

CHIEF ENGINEER, THE ATLANTIC REFINING COMPANY, PHILADELPHIA, PA. FELLOW ASME

With the ending of World War II and the rapidly expanding demand for petroleum products, it was realized that the domestic supply in this country would have to be augmented by bringing crude oil from the Middle East. About two years ago, therefore, the author was given the task of developing a suitable tank vessel design for this purpose. For bulk transportation of oil in tankers, it is axiomatic that the largest practicable ship is the most economical, and this is more emphatically true for long-haul service from foreign oil fields. In line with this reasoning, the vessel described in this paper was the largest tanker ever laid down at the time construction was started.

HULL DESIGN

The following principal dimensions were decided upon as being the maximum in view of the depth of water at ports of call and in the Suez Canal and the available number of dry docks of sufficient size:

Length over-all	660 ft
Breadth	85 ft
Draft, loaded	34 ft

A speed of 16–17 knots was decided upon as being desirable for the service intended and in line with modern practice. The maximum block and prismatic hull coefficients considered suitable for this speed without abnormal expenditure of power are of the order of 0.74 and 0.75, respectively (based on load-water-line length). A midship section coefficient of 0.982 with bilge radius of 6 ft and dead rise of 11 in. in 42.5 ft (half-breadth of the ship) completed the necessary fundamentals to enable a set of hull lines to be laid down. In connection with the 11-in. dead rise mentioned, it is noted that a number of the latest large tankers have been designed with flat-bottomed midship sections. This is an advantage for the designer, as it enables him to obtain finer ends on the hull for a given displacement, but the author's company believes that for satisfactory draining of tanks, when pumping out, a moderate dead rise is very desirable. With a flat bottom, it is necessary to list the ship first to one side and then the other, to drain the tanks completely, and this tends to complicate and delay unloading. A lines plan was completed, embodying the foregoing dimensions and coefficients, and an extensive series of model tests were made at both the Experimental Model Basin at Stevens Institute of Technology and the Navy's David W. Taylor Model Basin in Washington. These tests confirmed closely the preliminary estimate of 16,500 hp for 17 knots speed, with some margin for sea conditions, on a loaded displacement of 39,350 tons.

Modifications of the hull lines were tried out but involved some loss of valuable displacement and were discarded in favor of the form originally laid down.

Three propeller designs were tested with comparative results shown in Fig. 2, and the characteristics of the best one are given in the inset table in Fig. 3, which also gives the final model basin horsepower and rpm curves, etc., for the loaded condition of the ship. These compare favorably with most of the other recently designed supertankers for which similar data have been published. All these, at 16 and 17 knots, show a greater shaft horsepower per ton of displacement than the *Atlantic Seaman*, except in one or two cases where the rpm are lower, and the propulsive coefficient therefore somewhat higher.

Hull construction follows what has become practically universal tanker practice, i.e., twin longitudinal bulkheads and longitudinal framing. Based on Atlantic's experience with five 500-ft all-welded ships for eleven years, without any trouble from brittle fractures, the entire hull fabrication on the

Contributed by the Power Division and presented at the Annual Meeting, New York, N. Y., November 26–December 1, 1950, of The American Society of Mechanical Engineers.

present vessels should have been by electric-arc welding. However, due to the fact that the cause and cure of fractures in welded ships is still under investigation, with progress made but no final answer reported to date, the American Bureau of Shipping and the U. S. Coast Guard took the pessimistic view that cracks are still possible, and therefore crack stoppers must be provided to lessen the chance of their reaching serious proportions. Consequently, it was necessary to build the hull with eight riveted longitudinal seams extending over the amidship three fifths of the vessel's length. Since riveted seams have always been a tanker operator's headache, it is probable that those on the subject vessels may prove to be more trouble than they are worth, to say nothing of the 45 long tons of extra steel which the laps add to the ship's weight. This is equivalent to 315 bbl of crude-oil cargo which, needless to say, we would have preferred to add to the ship's capacity.

Another hull detail, more in line with modern progress in welded ship construction than riveted seams, is the serrated design of all longitudinal frames on shell, deck, and longitudinal bulkheads. These frames consist of reversed flanged plates and angles with a row of openings cut along the welding edge. These openings average about 8 in. in length and vary from 2 in. to 4 in. in height, depending on the depth of the bar. The inner corners are cut with generous radii, and the spacing, about 16 in. center to center, gives welding legs about 8 in. long. This construction results in a better distribution of material, saves weight, reduces welding, and the openings facilitate drainage and cleaning of tanks. It is the author's firm belief that continuously welded longitudinals act as integral parts of the shell plate, and therefore, in case of fracture, fail with the plate. This seems to be borne out by published photographs of fractured tankers, which show that continuously welded longitudinals have failed flush with the break in the shell. We do not believe this would have occurred if the longitudinals had been intermittently welded, as the hull plate could fail without causing a fracture in the stiffener.

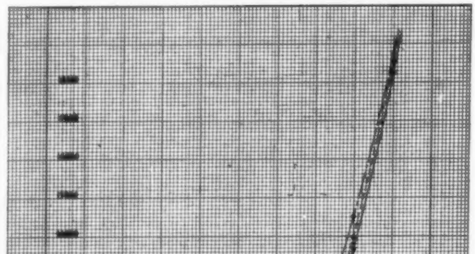

FIG. 2 COMPARISON OF MODEL PROPELLERS TESTED

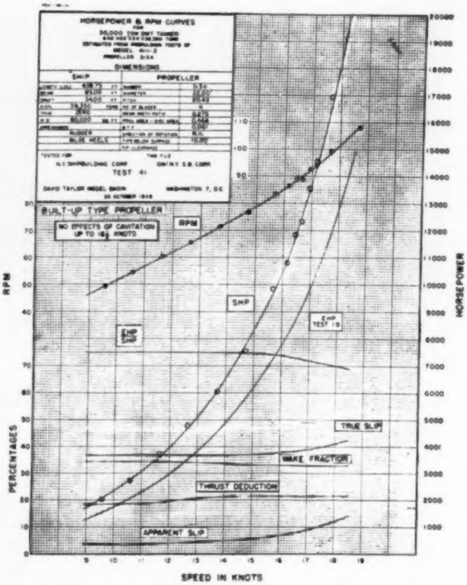

FIG. 3 MODEL BASIN CURVES—LOADED CONDITION

Accommodations for officers and crew are laid out to provide a maximum of comfort, convenience, and safety, with not more than two men berthed in any stateroom. All room bulkheads and lockers are either steel or asbestos-composition panels and furniture is of enameled steel or aluminum.

The ship is equipped with all modern navigation aids, including gyrocompass with gyropilot, course recorder, sonic depth finder, radio direction finder, loran and radar.

A general arrangement plan of the ship is shown in Fig. 4, and final finished dimensions and other particulars are given in Table 1.

POWER PLANT AND AUXILIARY MACHINERY

The "Van Dyke" class of Atlantic tankers, built from 1938 to 1941, were turbine-electric-powered vessels, the last five of which operated on 920 F steam. They have given very satisfactory and successful service including the arduous work during World War II and were the forerunners of the Maritime Commission's T2-SE-A1 type. The latter, however, did not have high-pressure, high-temperature steam plants owing to wartime shortage of required alloy steels.

In view of the success of the turbine-electric ships mentioned,

it will doubtless be wondered why the *Atlantic Seaman* class was fitted with geared-turbine drive. The explanation is that the electric-drive ships were designed primarily for the short haul from the Gulf to Philadelphia where rapid loading and discharge of cargo is of relatively great importance. For this reason, the main turbine-generator is used for supplying the current for large cargo pumps. The new vessels, on the other hand, are designed for the long haul from the Near East which is a 43 to 45 day round voyage where unloading time is of much less importance than economy of full power at sea over long periods. Also the space requirements of an 18,000-hp turbine-electric plant, as compared with the 5000 hp on the Van Dyke class ships would have posed a difficult problem.

The choice of a 650-psi steam pressure and 1020 F temperature was made because it is believed that 650 psi is about the maximum for a sectional-header-type boiler, and 1050 F is as high as can be used economically with that pressure. Higher temperature would simply result in greater loss to the condenser.

TABLE 1 FINAL DIMENSIONS AND PARTICULARS

Length over-all	660 ft
Length between perpendiculars	615 ft
Breadth, molded	85 ft
Depth, molded	45 ft
Draft, statutory summer load	34 ft $3^3/_{16}$ in.
Block coefficient	0.744
Midsection coefficient	0.982
Prismatic coefficient	0.758
Displacement, summer load draft	39664 tons
Dead-weight capacity, load draft	30155 tons
Cargo capacity (max)	257529 Bbl
Fuel-oil capacity, incl. reserve	29674 Bbl
Reserve feedwater	360 tons
Drinking water	100 tons

The sectional-header boiler is chosen for the same reasons as on the previous ships, i.e., simplicity of design and accessibility—no need to wait for drums to cool before plugging or renewing a tube. The operation and maintenance complications of an economizer are eliminated by the use of an air heater of sufficient size to reduce the stack temperature to about 325 F, which we believe is as low as should be used.

Lower temperatures are apt to be below the dew point of stack gases, when using low-cost fuel with high sulphur content, and may cause excessive corrosion of the heater tubes. Reference to the heat-balance diagram, Fig. 5, will show that a feedwater temperature of 315–320 F is obtained by means of bleed-steam heaters, and we believe this is higher than obtained on other modern vessels using economizers.

HEAT BALANCE

The heat balance is based on four bleed stages from the main turbine. The condensate at 28.5 in. vacuum, 92 F is pumped in series through the inter- and aftercondensers, evaporator condenser, low-pressure drain cooler and low-pressure heater to the deaerator. The feed pump takes suction from the latter which is some 50 ft above it, in the engine hatch, to provide positive suction. The pump discharges through a high-pressure drain cooler, intermediate and high-pressure heaters to

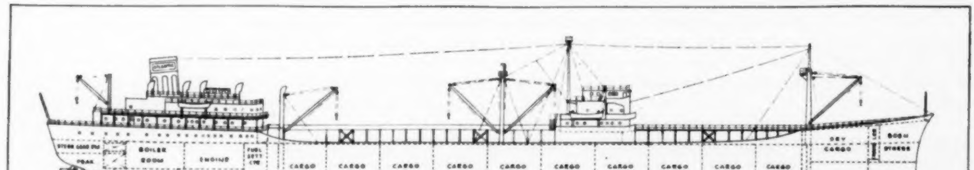

FIG. 4 GENERAL ARRANGEMENT PLANS

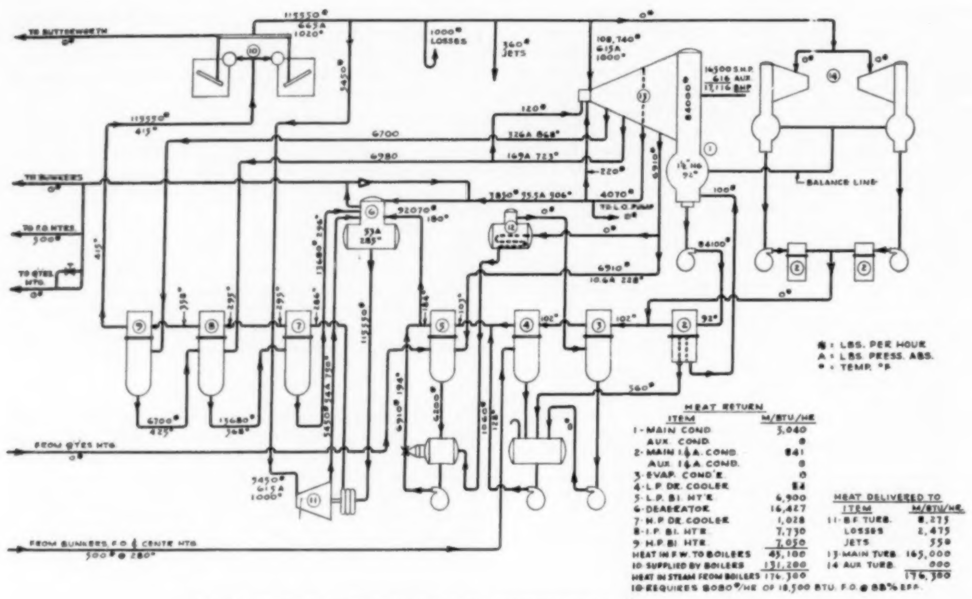

FIG. 5 SIMPLIFIED MATERIAL AND HEAT DIAGRAM OF S. S. "ATLANTIC SEAMAN"
(As calculated for normal power operation using "attached" generator for auxiliary power.)

the boilers at a calculated final temperature of 415 F as previously stated.

In order to reduce scaling to a minimum, evaporators are operated at approximately 3 psia, using the lowest available bleed-steam pressure. A connection is also provided to the low-pressure heating-system steam supply so that operation in port may be had when necessary. The deaerator has a triple function. It serves not only as a deaerator, but also as a direct-contact heater for the feedwater and a desuperheater for the service steam used for bunker and quarters heating, the fuel-oil heaters and the emergency turbine-driven lubricating-oil pump. It should be noted here that desuperheated steam is not used on this vessel for any auxiliary. This heat-balance arrangement gives a predicted economy of 0.473 lb of 18,500-Btu fuel oil per bhphr or 0.491 lb per shphr for normal running conditions, these figures being based on manufacturers' guarantees for boilers, and main and boiler-feed turbines. The reason for the distinction between bhp and shp just given is the fact that the main propulsion unit has an attached auxiliary generator driven from the intermediate gear shaft. This unit normally supplies all the auxiliary electric power required by the ship, and the 0.49 lb per shphr mentioned is, therefore, the total for all purposes under the predicted normal conditions and not the net figure for propulsion only. Normal conditions include galley ranges in use, lights, fresh-water and sanitary systems, ventilating system, etc., in full operation. Comparative heat balances based upon normal operation indicate that the use of the attached generator saves seven barrels of fuel per day as compared to carrying the same load with one of the auxiliary turbine-generator sets.

STEAM GENERATORS

The two water-tube boilers are of the single-drum sectional-header type, each rated at 65,000 lb of steam per hr at 650 psi and 1020 F, or 78,000 lb per hr at 625 psi at the same temperature. Heating surface per boiler is 8869 sq ft, including waterwalls, plus 2570 sq ft of superheating surface and 8750 sq ft of air-heater surface. Superheat control is by means of a desuperheating coil in the drum and arranged on an automatically controlled by-pass ahead of the third pass of the four-pass superheater. This by-pass comes into operation at about two-thirds normal load, below which it is not needed. This type of superheat control has been entirely successful on nine previous ships during the past twelve years, and it has never been necessary to renew a turbine blade due to heat damage. Boilers are each equipped with four double nozzle wide-range burners which incorporate an invention of the author consisting of a small center tip spraying through a larger outer one. A three-way cock allows either or both tips to be used and provides a very wide range of operation (9 to 1) without the necessity of pulling burners. The boilers are fitted with double casings, welded as completely as practicable to prevent air leaks, and steel bellows-type expansion joints are used at uptake connections and in the forced-draft ducts. Three constant-speed forced-draft fans are installed, two being used in normal operation with the third as a stand-by. Each fan outlet is fitted with a blast-gate type of shutoff damper, the more usual butterfly type not being considered sufficiently airtight. Air heaters are designed with two passes on the air side and are equipped with by-pass dampers to prevent sooting up under low load or stand-by conditions. Boilers are fitted with continuous automatic air-puff soot blowers operating under 200-psi air pressure which insures adequate blowing. They blow alternately, first on one boiler and then on the other, a complete cycle requiring about three hours. The use of air-puff soot blowers, rather than steam blowers, prevents loss of valuable distilled water and does a satisfactory job if sufficient air pressure is used.

MAIN STEAM PIPING

The design of the main steam piping for 1020 F presented somewhat of a problem since the ABS and USCG rules at the time did not contemplate temperatures of this order, nor did they include allowable stresses for such alloys as 2 per cent chrome, $^1/_2$ per cent moly, or $2^1/_4$ chrome, 1 moly, which latter it was finally decided to use. Fortunately, both of these agencies were found extremely open-minded and co-operative, and the recently published "Interim Guide" was developed and adopted in time to use in designing the steam piping for the subject vessel. The flanges also were given special consideration, which enabled us to use the 900-lb series slightly thicker than standard instead of the 1500-lb series which a strict application of the rules would have required. Some idea of what this co-operation meant in weight saving may be gained from the fact that extrapolation of the rules existing when a study of the steam piping was started would have resulted in a 10-in. main steam line about $1^1/_4$ in. thick, with 1500 series flanges, whereas the modernization of the rule permitted the use of an 8-in. pipe, 0.509 in. thick.

Corresponding reduction made in the smaller sizes of pipe used resulted not only in considerable weight saving but increased flexibility and reduced temperature stresses. The author wishes to express his appreciation of the valuable assistance of both the ABS and the technical section of the U. S. Coast Guard whose open-minded co-operation has contributed greatly to the modern design and expected success of these vessels.

Flanged joints are standard ASME male and female type with $^1/_4$-in. raised face and $^1/_4$-in. recess which allows an appreciable entry of the raised face into the recess before seating on the standard-thickness Flexitallic gasket. This type of joint has given perfect satisfaction for many years on Atlantic ships. Uniform bolt tension is obtained by the use of torque wrenches, and even gasket compression is checked with feeler gages between flange faces. Cold pull-up of piping subject to expansion strains was accomplished by inserting machined "dutchman" pieces of proper thickness between flanges when fitting and removing same when finally bolting up. This procedure removes all doubt as to amount of cold pull-up. All high-pressure steam piping is supported on constant-tension hangers with hydraulic snubbers placed where necessary to prevent sway and vibration. This method of support assures ample allowance for expansion and minimum stress at the connections to the various units of machinery.

MAIN PROPULSION UNIT

The main propulsion unit is a cross-compound steam turbine with double-reduction gear, a two-pass condenser and attached 700-kw auxiliary generator, driven from the starboard intermediate pinion shaft. The entire unit complete with lubricating-oil pumps and coolers, inter- and aftercondensers, steam jets, control-valve manifolds, gland steam system, and all interconnecting piping was supplied by the turbine manufacturer. The high-pressure turbine is an impulse-reaction type, and the low-pressure turbine a single-flow reaction type, with astern rotor at the exhaust end. The exhaust trunk is welded directly to the condenser inlet to eliminate possible leakage of a large flanged joint. Condenser tubes are 70-30 cupronickel which we have found have a life of more than ten years when used in conjunction with the double-bottom deaerating tank described herein. Three lubricating-oil pumps are built into a well in the gear case, one bevel gear driven from the main bull-gear shaft, one a steam-turbine-driven unit which starts up automatically when oil pressure drops below a set minimum, and an electric-motor-driven pump to be started manually in emergencies or when the main turbine is shut down and is being driven by the turning gear. It should be noted that no gravity lubricating-oil tank is fitted or required. It has been the author's experience that overhead tanks for gear lubrication will pull air into the system, and it is well known that oxygen in a gear case is detrimental to gear life. A further precaution against the entrance of oxygen into the gear case is a special packing gland around the main drive shaft. The gears are arranged in what is generally known as the nested pattern and reduce the turbine speeds of 6450 and 4280 rpm to a propeller-shaft speed of 100 rpm at normal full load.

THRUST BEARING

The main thrust bearing is not a part of the gear assembly, but is a separate Kingsbury type double, eight-shoe unit located aft of the reduction gear so that no thrust load is carried into the latter where it might cause distortion of the case and consequent misalignment of the gears. The thrust bearing is provided with a self-contained oil cooling system and is supported on a foundation long enough to carry two self-aligning steady bearings, one forward and one aft of the thrust bearing. Provision has been made for future installation of a thrust meter,

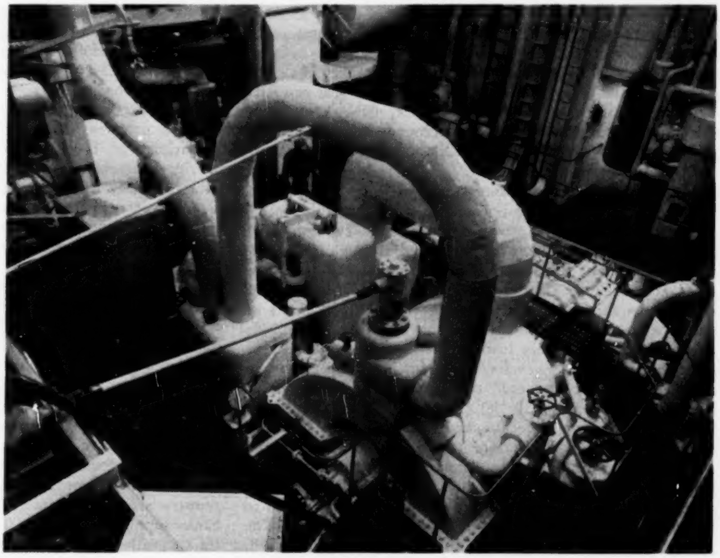

FIG. 6 MAIN TURBINES OF S. S. "ATLANTIC SEAMAN"

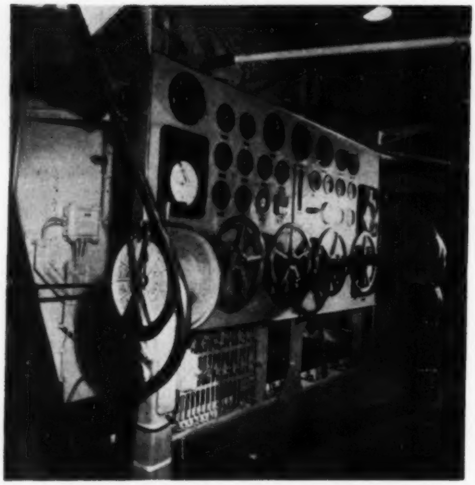

FIG. 7 PROPULSION CONTROL BOARD

if desired. A shaft torsion meter is also installed for measurement of horsepower.

AUXILIARY MACHINERY

Auxiliary Generators. Electric power and light for the ship is supplied by two geared-turbine generator sets, each consisting of one 750-kw 60/50-cycle, 450-v, a-c synchronous generator, one 15-kw, 125-volt, d-c generator for miscellaneous direct-current requirements, and one 15-kw, 125-volt d-c machine for excitation purposes. These two auxiliary sets are also of the "package" type, similar to the main unit, with turbine and generators all mounted on a single bedplate, condensers welded to exhaust nozzles, air ejectors and other accessories all arranged in a compact unit. The generator attached to the main gear case, already mentioned, is a 700-kw, 60/50-cycle, 450-volt, 600-rpm machine which is used to carry all electric auxiliaries when the ship is at sea, running steadily under normal full-load conditions.

The 750-kw auxiliary turbine-generator units are arranged so that either one may be operated as a synchronous motor, taking current from the attached generator and dragging its turbine on which vacuum is maintained through a connection to the main condenser. When the attached generator speed falls to approximately 52 cycles, due to necessity for slowing the ship, the speed governor automatically starts to open the steam admission valve so that the auxiliary turbine assumes the full auxiliary load by the time the attached generator has slowed to 50 cycles. A circuit breaker between the attached generator and each of the auxiliaries opens automatically, when one of the latter takes over, and prevents it from trying to motor the attached machine. This breaker's opening also brings the turbine set up to 60-cycle speed and automatically sarts up the condensate and circulating pumps for the auxiliary condenser. When the attached generator is again above 52-cycle speed, the turbine unit can be returned to "motorized" operation. This is a manual operation. The two generators are synchronized, the circuit breaker is closed, the water pumps stop, and the speed governor on the auxiliary turbine is reset at its lower limit of 52 cycles. This cuts off the steam but leaves the governor ready to open and causes the turbine to reassume the load if the attached generator speed again drops below 52 cycles. This system has been in use for years on the Van Dyke class ships, is entirely successful and reliable, and has been applied to the T-2 tankers owned by the author's company as well as others.

The nonbleed water rate of the *Atlantic Seaman* main turbine is 5.48 lb per shphr or 7.25 lb per kwhr, whereas the auxiliary-turbine water rate is 9.26 lb at 700 kw and 9.48 lb at 600 kw. This explains the estimated saving of 7 bbl of fuel per day through the use of the attached generator which was mentioned earlier in this paper. The general arrangement of machinery in the ship is shown in Figs. 8 and 9.

Switchboard. The main switchboard is a "dead-front" design, of all-steel construction, located on a flat directly above the auxiliary generators, thus providing short cable runs. All switching devices are circuit breakers which can be removed for servicing without de-energizing the buses. Starters for all auxiliaries, including cargo pumps, are located behind the switchboard with push-button control stations located adjacent to the equipment. This arrangement places all electrical control gear in one place for easier servicing and protection from steam, water, or other hazards and is in line with Atlantic practice of many years. Starters are equally divided into three groups and controlled by a breaker on the switchboard so that the opening of any one does not result in a complete shutdown of auxiliaries. Indicating lights are provided on the switchboard for the essential engine-room auxiliaries and steering-gear motors, and these are automatically restarted in proper sequence in the event of complete power failure. Automatic transfer equipment, both 450-volts a-c and 125-volts d-c is connected ahead of the generator breakers to provide uninterrupted power supply to the steering gear and lighting system in the event of breaker opening.

Motors. All a-c motors, other than a few small sizes operating on lighting circuits, are 440-volt, 60-cycle, 3-phase, Class 2, marine-type, totally enclosed, except those in hazardous locations which are Class 1, explosion-proof. All motors, except the larger sizes and the explosion-proof types, have sealed ball bearings, permanently lubricated and guaranteed for 5 years. The 500-hp cargo-pump motors and all generators are equipped with space heaters to prevent sweating when not in use.

Electric Cables. All electric cables have varnished-cambric insulation with bronze basket-weave armor, except those for interior-communication circuits which are rubber-insulated. Cables on deck from poop to bridge and bridge to forecastle require special protection against salt-water and sea damage, corrosion of supports, etc., and must have provision for expansion and contraction. Based on the experience of many years, we have placed these cables on the inside of a solid stainless-steel plate bulwark rail on the fore-and-aft gangway. This arrangement applies only to the gangway from poop to bridge where a comparatively large number of cables must be run. The smaller number running from bridge to forecastle are placed in the bosom of a channel or flanged plate on the side of the gangway at grating level. All cables are secured by lead-lined straps spaced every 14 in.

Lighting and Galley Equipment. Six single-phase, 15-kva, 115-230-volt air-cooled transformers are installed behind the main switchboard, divided into two banks, and connected delta-delta. An induction-motor voltage regulator is connected on the primary side to maintain constant voltage. One of these banks supplies current for the lighting system and the other for the galley range, bake oven, etc. Fluorescent lamps are used for lighting quarters and incandescent lamps with vapor-tight fixtures in other spaces. There are no cables, wires, or

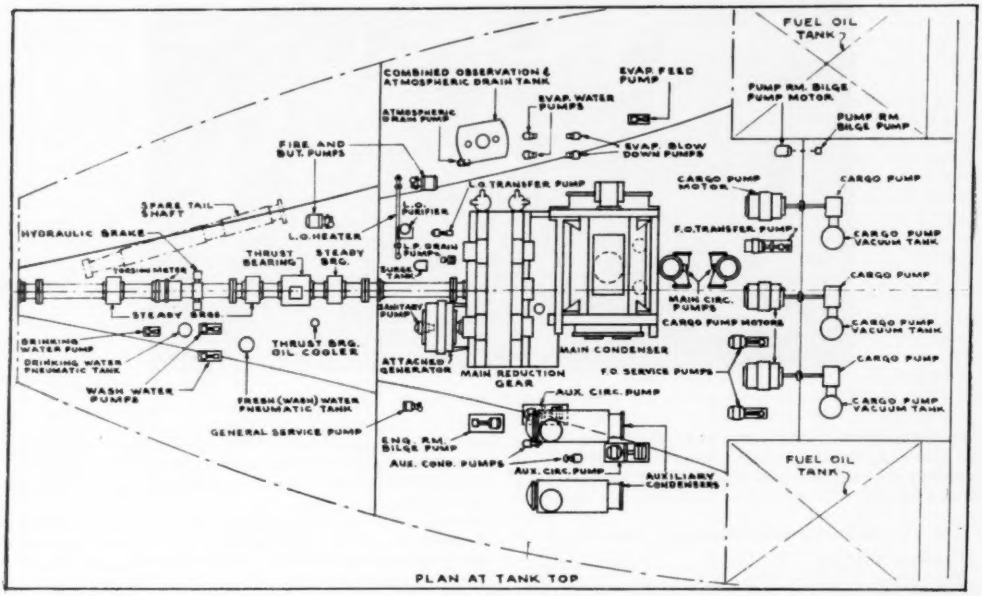

FIG. 8 ARRANGEMENT OF MACHINERY

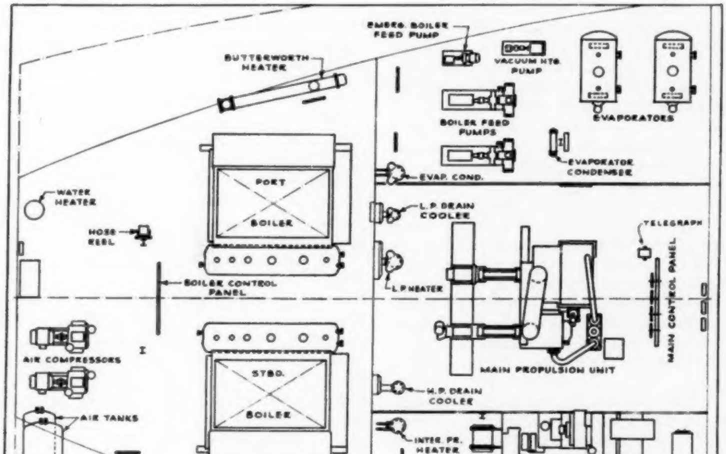

FIG. 9 ARRANGEMENT OF MACHINERY

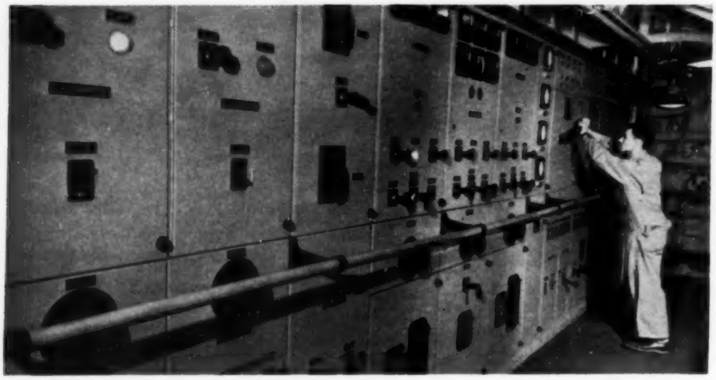

FIG. 10 MAIN SWITCHBOARD

lights inside the main pump room which is illuminated through bulkhead or deck deadlights with fixtures on the outside. In other locations considered hazardous, class 1 explosion-proof fixtures are used.

AUXILIARY ENGINE-ROOM EQUIPMENT

Salt-Water Deaerating Tank. The use of a deaerating tank built into the double bottom of the ship has proved so phenomenally successful on the Van Dyke class ships that its adoption for the present vessels was a foregone conclusion. All salt-water pumps in the engine room take suction from this tank which is fed through large high and low sea chests, port and starboard, and this arrangement eliminates the need for other sea connections. Vent pipes from the top of the tank extend well above the water line and serve as constant vents for entrained air coming in through the sea chests. Two vertical centrifugal main circulating pumps are set directly above the deaerating tank, and all pump-suction pipes extend close to the tank bottom where the chance of picking up air is a minimum. Each of the main circulators supplies one side of the condenser but a crossover is provided so that if one pump fails the other can supply both sides.

Boiler Feed Pumps. Two six-stage. 350-gpm, centrifugal, boiler feed pumps are each driven by a 250-hp turbine taking steam at full boiler pressure and temperature as do the auxiliary generator turbines. It is believed that whatever slight loss in economy there may be in this arrangement, it is more than justified by the elimination of reducing valves and other complications incident to providing steam at various pressures and temperatures. The exhaust from these turbines is used in the deaerator for feed heating so that the heat in this steam is returned to the plant.

Instrumentation. In line with modern practice and to facilitate keeping the power plant at maximum efficiency, a number of recording and indicating instruments are installed. Steam flow and temperature from each boiler are recorded, the flow, pressure, and temperature to the main turbine, and the flow and pressure to the auxiliary turbine-generators. Combustion air and stack temperature for each boiler are recorded, and a salinity recorder is provided for checking the purity of boiler feedwater leaving each of the condenser hot wells and the drains inspection tank.

Automatic combustion control (steam flow-air-type) is installed to maintain a constant outlet pressure from the boilers. Automatic two-element feedwater control is used to maintain constant level in the boiler drums, and constant superheat temperature is kept, as previously mentioned, by an automatically operated by-pass through a desuperheating coil on the boiler drum.

In addition to the foregoing, a sufficient number of indicating thermometers and pressure gages has been installed so that the operating condition of any part of the plant can be determined easily. Provision has also been made for the installation of test gages, thermocouples, and thermometers for obtaining more complete heat-balance data during tests than normally would be possible with the permanent instruments installed. It is the author's belief that the instrumentation outlined is far ahead of anything heretofore placed aboard a ship. It is not, however, ahead of good land-plant practice, and why the same engineering standards are not maintained on marine propulsion plants is still a mystery to the author.

CARGO PUMPING SYSTEM

Three single-stage, motor-driven, centrifugal cargo pumps are located in the pump room just forward of the engine room. Their combined rated capacity is 20,000 bbl per hr which is sufficient to unload the ship in about 12 hours. The pumps are driven by 500-hp motors located in the engine room and connected by jackshafts with flexible couplings extending through stuffing boxes on the bulkhead.

The use of electric power for cargo-pump drive instead of steam turbines required, of course, large auxiliary generating sets, but eliminated the complications of the steam and condensate system which the turbine drive would have involved. A study of cost also revealed that the electric system adopted, including the extra cost of the larger generating sets, was cheaper than the steam plant would have been. No stripping pumps or stripping lines are used, the stripping operation being accomplished with entire satisfaction by having the main cargo pumps automatically and continuously primed by vacuum priming pumps. This arrangement has been an Atlantic practice for many years and, as stated previously, is completely successful, saves weight and complications, and speeds up unloading by permitting the cargo pumps to run at full capacity until tanks are practically empty.

STEERING GEAR

The steering gear is of the conventional electric-hydraulic type with two horizontal-opposed rams connected to a crosshead on the rudder stock and with power furnished by dupli-

cate Hele-Shaw type oil pumps driven by 125-hp motors. Steering is by two entirely independent electric controls using Selsyn motors on separate circuits from bridge to steering gear.

One of these controls is arranged for either hand or automatic steering through the usual gyropilot and is a full follow-up self-synchronizing system. The alternative control is a non-follow-up type operated by a small lever on the right-hand side of the steering column. Any of the three systems is instantly available to the helmsman without moving from his position by shifting the three-point selector lever on the left side of the steering column. In addition to the three methods of steering from the bridge, there are four emergency hand-steering stations aft, one at the forward end of the boat deckhouse top and three in the steering-gear room—the latter consisting of a trick wheel for direct control of each hydraulic motor, and the third a four-man hand pump for use in case of failure of both power pumps.

DECK MACHINERY

Deck machinery consists of the anchor windlass and one warping or dry-cargo winch on the forecastle deck, two warping winches on the upper deck, and two warping capstans on the aft end of the poop deck. All these machines are hydraulically operated from two 125-hp electric-motor-driven hydraulic pumps, one located forward and one aft, and arranged with the necessary automatic valves so that all units may be operated simultaneously or independently. The A-end hydraulic power units are both located below decks so that no electric motors are required to be outside, exposed to weather and salt water. The advantages of hydraulic drive with its great flexibility of speed control are well known, and it is believed that this is the first time it has been applied to all deck machinery on a ship.

VENTILATION

Ventilation of machinery spaces is by means of propeller-type fans inside and below the deck-cowl trunks which can be rotated in the usual manner to face the wind. The fans assist the natural air flow and force air to the various delivery points in the engine and boiler rooms. There is also an exhaust duct and fan drawing hot air from a hood above the auxiliary turbine-generator units and discharging to atmosphere above the fiddley top.

Both forward and aft quarters are equipped with forced-air distribution systems of sufficient capacity for a change of air every 4 min. When necessary, this air is heated to maintain a comfortable temperature in the rooms. In hot weather it is used for ventilation only and is supplemented by large attic-type exhaust fans which draw air out of the passageways and the rooms opening into them. These fans have about 4 times the capacity of the forced-air fans, in order to insure very adequate air circulation in hot weather.

In addition to this system, all washrooms, bathrooms, and laundries have individual exhaust fans of capacity to provide an air change every 2 min. The galley is provided with a 3000-cfm fan exhausting from the hood above the electric range.

PERFORMANCE

The most intriguing engineering is of little value unless it results in performance in accordance with design. Delayed delivery of the *Atlantic Seaman* resulted in the completion of the maiden voyage only a few days before this paper was presented. Consequently, performance data to date are somewhat sketchy.

The hull has surpassed our most optimistic predictions. At designed speed there is a minimum of water disturbance and air entrainment is exceptionally low. The bow and stern wave patterns are remarkably flat and smooth for a vessel of this speed, indicating a minimum waste of power in wave-making. The ship answers her rudder quickly, and on trials with helm hard overturned a tight circle of about 0.6 mile in diameter. On the maiden voyage, in ballast condition, the horsepower meter on the shaft indicated an average of 16,031 shp at 100 rpm with a speed of about 18.6 knots. Within limits of accuracy of observation and without the usual allowance for sea conditions, this is an exact check on predicted performance.

The constancy of steam temperature and pressure under automatic control is almost unbelievable. Fig. 11 is a reproduction of a chart from the meter measuring steam flow to the main turbine. The trace nearest the center is pressure, the middle trace temperature, and the outer one steam flow. The slight variations from smooth traces shortly after 4:00 a.m. and 4-hr intervals thereafter, are caused by inspection of burner tips by each watch. Steam temperature did not exceed design maximum, even during a crash stop. The oil burners described elsewhere in this paper performed as expected and it was not necessary to change tips or remove burners for fluctuating loads varying from stand-by to overload.

A measurement of fuel consumption, during a 24-hr period of the ballast run, showed a consumption of 7986 lb with a horsepower reading on the torsion meter of 16,031 shp which gives a figure of 0.498 lb per shphr. This was obtained with vacuum of 27.9 in. Corrected to design vacuum of 28.5 in., the figure becomes 0.489 lb per hphr, which checks with design expectations. This, it should be noted, includes fuel for all purposes; no attempt having been made to eliminate any normal use of power during the test period.

The maiden voyage of 3720 miles (sea passage) was made at a speed of 18.5 knots in ballast and at 18.09 knots loaded, without a shutdown of the power plant. After completion of the first voyage, obstructions, consisting of a pair of pants, a shirt, and a sock were found in the cascade seal pan of the main condenser so that perhaps the author may be pardoned for predicting further improvement under more nearly normal conditions.

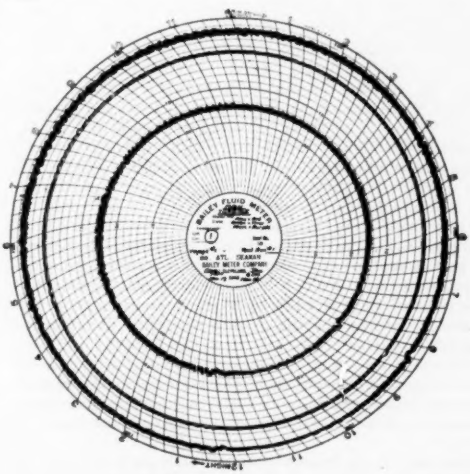

FIG. 11 STEAM FLOW CHART

The TECHNOLOGY *of* PORCELAIN ENAMELING *on* STEEL

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HISTORY

ENAMELING is primarily the process of fusing glass to metallic or ceramic surfaces. In the case of pottery it is called "glazing." More generally the term is used to express the idea of producing a highly lustrous finish on wood or metal by the application of paint or lacquer. It has also a certain significance in cosmetics. Glasslike gloss is a characteristic quality of all such enamels. The word "enamel," representing the material used, comes in a roundabout way from the Old High German "schmelzan," and the Old French "email" (Latin *smaltum* = enamel), which became "amel" in English, later strengthened by the prefix "en" to form the modern word properly meaning a fused substance. Therefore the word enamel is more exactly used to define the process herein considered than in the other connotations.

The origin of vitreous enameling dates back to antiquity, when it was employed in making small decorative articles. It was natural that the Egyptians, who are credited with the discovery of glass, should have been the first to apply that material to metal. Through the years the process became a fine art. In their artistic forms enamels were applied successively to gold, silver, bronze, and copper. The next step was to use iron as the base metal and in this direction enameling advanced to its most important present-day usefulness. The advent of the machine age with its rapid progress in chemistry and metallurgy and its great changes in industrial and social régimés stimulated the development of enameling for utilitarian purposes.

In the early part of the nineteenth century enamels were applied first to iron castings. The enamel in the form of a fine dry powder was dusted on the red-hot surface upon which it softened and to which it adhered. The piece was then returned to the furnace whereupon the enamel melted to form a smooth glass. By repeating this process several times it was possible to build up a layer having the desired thickness and appearance. At first the operation was crude and inefficient, but it was fundamentally the same method which, after much modification and improvement, is in use today in the production of vast quantities of sanitary ware. Enamel technology has in fact evolved side by side with sanitation.

The enameling of sheet iron was a later development begun in Austria and Germany about 1840. The first manual of enameling, published in 1851, reveals that the process was growing in accordance with the best chemical knowledge of the time. The industry grew steadily with the improvements in the technology of iron and the cheaper production of the pertinent raw materials.

Changes in the manufacture of steel improved the properties of the metal and the fabrication of sheets into a greater variety of forms became possible. At the same time difficulties were encountered in that the traditional enamel compositions were no longer adequate. Better appearance, adherence, and other properties were demanded, and in the development of the necessary new formulas the resources of chemistry and physics were drawn upon to an even greater extent.

A marked advance was made when it was discovered that clay can be used to keep powdered enamel glass in suspension in water and that its presence improves the adherence to the metal before firing. This suspension, called a slip, which was painted or poured on the metal or into which the ware was dipped and the excess drained or shaken off, was dried and finally fired to produce a greatly improved enamel coating. The spray gun, so generally used today, was a relatively late development which made possible the uniform application of enamel to surfaces of large area. More recently the development of automatic spraying has resulted in increased production of enameled ware of the highest quality.

Enamel slips are employed in the production of sheet-iron and cast-iron ware. The use of slips in enameling cast iron is known as the "wet process" in contradistinction to the method whereby dry enamel powder is sifted onto the red-hot surface, which is called the "dry process."

The greatest advances in commercial enameling have been made since the turn of the century. The number of plants and the variety of products have increased rapidly so that the enameling industry has attained considerable magnitude, and its importance in the daily life of the people is in proportion to the desire for more civilized living. This advancement has been accomplished largely by a recognition by the manufacturers of the importance of the application of the principles of chemistry, physics, and engineering to the industry. Whereas the enameling of metal was once an art practiced empirically with materials and processes guarded by the utmost secrecy, now through research and development, it is taking a prominent place in the ranks of the applied sciences.

COMPOSITION OF ENAMELS

Enamels are glasses which melt at relatively low temperatures. They are made by fusing refractory materials, such as quartz and feldspar, with fluxes, such as borax, soda ash, fluorspar, cryolite, lead and zinc oxides, and adding opacifying substances (oxides of antimony, zirconium, and titanium) and color oxides as required. In practice the principal constituents are intimately mixed and heated at 2200 to 2300 F from 4 to 6 hours—a process known as "smelting." The melt is poured into cold water, which chills the glass and causes it to break up to form a "frit." This frit is essentially an alkaline boro-silicate glass, the minor constituents of which are in solid solution or suspension. The frit is prepared for use in the form of a slip by ball-milling with water and a so-called mill addition. In the mill addition are included clay and electrolytes, which serve to keep the solids of the slip in suspension. Specially compounded opacifiers and color oxides are sometimes introduced into the enamel slip as part of the mill addition.

The quantities of these materials used in enamel formulation vary over a wide range according to the particular purpose for

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which the enamel is to be used. Thus an enamel which is intended to be applied directly to the metal and to adhere strongly to it (ground coat) differs considerably in composition from one which is to be used to provide the highly lustrous, hard and perhaps colored, finished surface (cover coat).

The composition of an enamel is complicated by the number of elements present and their varied sources. It is a glass, as has been stated, formed by fusion, solution, and reaction of a number of raw materials. An enamel is an undercooled solution, but in addition it holds in suspension opacifiers, color oxides, and gases. It might be considered to be a solid emulsion and suspension, because the opacity and color are due in many cases to the dispersion of these materials throughout the matrix of glass. These particles are so small that they cannot be seen even with a high-power microscope. Some are crystals produced when the glass cools, others are caused by the dispersion of solid particles in the molten glass, and still others are attributable to immiscible melts dispersed in the molten magma. Enamel glasses are therefore similar to water solutions, suspensions, and emulsions, and there is evidence to show positively that they are subject to the same general laws as other systems of these types. As clay may be suspended in water, so are opacifiers suspended in the glass. It is highly probable that the electrolytes are effective in the dispersion of the opacifiers in the same manner as they effect the dispersion of clay in a slip.

Chemical changes take place in the formation of enamels but it is doubtful that the reactions are complete. It is quite probable that if these reactions did go to completion the enamel would not remain vitreous, but would crystallize and devitrify, in which case the ultimate composition would be indicated by the crystals formed. Consequently the chemical analysis of an enamel is difficult to interpret, and the successful deduction from the composition of a finished enamel of the nature and quantities of the materials used in its preparation requires intimate knowledge and long experience. The problem is further complicated where the enamel has been applied to an iron surface and fired, because of the physical and chemical changes that have taken place. In drying, water evaporates from the slip carrying soluble salts to the surface and concentrating them there. The iron rusts and some of this oxide is dissolved by the fused enamel, as indicated by discoloration. During the firing this oxide changes from red to black in color, the iron is further oxidized, and a scaly layer forms between the enamel and the iron. With further heating the black oxide disappears, probably going into solution in the enamel. The gases in the enamel and those formed at the interface slowly escape through the molten enamel, and finally the glass settles down to form a smooth surface. These changes are very complex and affect not only the physical condition but also the chemical composition of the enamel.

In a comparable manner where the second coat is applied over the first, dried and fired, volatilization, decomposition, solution, and reaction occur, all of which tend to change the composition of both coats.

Thus, while the chemical composition of an enamel frit is largely controlled by the contents of the raw batch, the effects of smelting, milling, application, and firing have to be considered in working out the formulation. In order to attain uniformity, great care must be exercised to maintain constancy in the conditions of operation, else a frit that works well at one time or in one place may not be at all satisfactory at another time nor in another place. The problems involved in the manufacture of enamel frits are so complex that the latter has become a separate business which supplies the frits required by individual enameling concerns, and through its highly specialized experience does much to improve the economics of the enameling industry.

MANUFACTURING ENAMEL FRIT

The manufacture of frit involves the usual mechanical operations of materials-handling, weighing, and the introduction of the raw materials into the smelting furnace, all of which are standard and well understood and need no specific discussion here. Smelting may be carried out in crucibles, in reverberatory furnaces, or in rotary furnaces, generally gas or oil-fired. Electrically heated furnaces are used to a limited extent. In some plants the operation of the reverberatory smelters is continuous, and considerable improvement in thermal efficiency can thus be obtained.

The chemical reactions and physical changes which take place among the raw materials at temperatures up to 2200-2300 F are necessarily complex, as has been brought out, because the components of the batch have different fusing and volatilization temperatures. The reactions are comparable to those involved in preparing a silicate mineral for analysis by fusion with sodium carbonate. When the melt has reached a condition where sample threads of glass are smooth and homogeneous, usually in 4 to 6 hr, the liquid mass is allowed to run into cold water and is there quenched. The rapid cooling causes the glass to crack and break into small particles which can be easily reduced to a fine powder. The uniformity with which this process is carried out has an important influence on the subsequent milling operation. Usually the molten glass is discharged in a thin stream which is met by a jet of cold water which breaks it up into small drops and threads which are quickly cooled. Being small, hot centers and uneven cooling over a longer time are avoided. It has been suggested that the glass could well be quenched by air alone according to a process similar to that used in making mineral wool. This operation would appear to be advantageous in many ways, but has not come into general use probably because of the difficulty in handling and the necessity for more storage space for the fluffy material.

When frits are made in the plants in which the enamel slip is to be prepared, they may or may not be dried, but in the latter case moisture determinations must be made to insure adequate control. Frits, however, are generally manufactured in separate plants, as explained, and, therefore, a drying operation must be carried out by means of a drying table or chamber, or in a rotary kiln, heated by the waste gases from the smelting furnaces. The rotary kiln can be made to operate continuously, the wet frit charged at one end being dried as it passes through the hot gases moving in the opposite direction, and removed at the other. By the use of a system of flues in the wall of the drier, contamination by dirt from the flue gases can be avoided. In most cases the dry frit is passed over a magnetic pulley to remove iron or iron-bearing slags.

PREPARATION OF ENAMEL SLIPS

Milling. The milling of enamel frit is generally carried on in the enameling plant. The operation requires careful control because the working properties of the slip and the quality of the finished enamel are largely dependent upon the accuracy and the uniformity of the processes involved. Every effort must be made to maintain a high degree of cleanliness and to prevent any kind of contamination. For this work ball mills are always used, and necessarily the materials must be handled in batches which are weighed and placed in the mill with water. The grinding requirement is usually that all the finished enamel slip shall pass a 60 or 100-mesh screen, but generally the specification calls for a certain percentage of residue on a finer screen. This requirement is expressed by the number of grams remaining from a 100-gram sample on a 200-mesh screen. The fineness of the material influences the colloidal behavior of the slip. The

working properties of the slip are dependent upon the colloidal content added as clay or formed in the milling operation. The properties of these colloids are influenced by the soluble salts in the mill liquor, which, too, may be either added to the charge or developed in the process. All frits are soluble in water to some extent, and the soluble material not only affects the colloidal properties of the slip but also influences the activity of added electrolytes.

The properties of the finished slip are controlled by determinations of the fineness, consistency, and the specific gravity which are governed by the purpose for which the enamel is to be used. Sheet-iron ground coats are usually lighter and coarser than cover coats. The degree of milling profoundly affects the behavior of the enamel in drying and firing, and the weight of application depends upon the specific gravity of the slip.

At the conclusion of the grinding operation, the mill is discharged, and the slip is screened to remove large particles which may interfere with its smooth application. When the slip is removed from the mill it is usually warm from the heat generated by friction in the process and its properties are different from what they will be after cooling. Most enamels are improved by aging, and therefore are allowed to stand for 1 or 2 days to cool completely and to attain a condition of approximate equilibrium. Aging also facilitates the removal of air which may be trapped in the slip during milling. The time required to come to equilibrium varies and to an important extent depends upon the solubility of the frit in the mill liquor. The slips easiest to use are those which approach equilibrium quickly and maintain it over long periods of time.

Mill Additions. From the standpoint of the quantities used, mill additions are actually minor constituents of enamel compositions, but they have important effects on enamel behavior both before and after firing. They can be classified into four groups, i.e., floating or suspending agents, electrolytes, opacifiers, and colors. The water used in milling should be as nearly pure as possible. In an increasing number of plants water is purified at relatively low cost by the ion-exchange process.

Suspending Agents. Clay is the material most commonly used for keeping enamel slips in suspension, and the selection of the proper grade for the purpose is very important. No satisfactory tests of the quality of so-called enameling clays have been devised, and the final decision as to their suitability must be based on the results of actual trials. The clay should be fine-grained, highly plastic, and practically free from both mineral impurities and extraneous organic matter. Its effect on the fusibility of the enamel should be known, as should its influence on the acid resistance. It may or may not influence the opacity of the enamel. It is important that the clay should promote good adherence to the ware and sufficient hardness to enable handling in the bisque or dried state. It has been found that certain ball clays and very plastic fire clays best fulfill the requirements, especially where they are used in the form of blends. For many years clays from Vallendar in Germany were considered to be almost indispensable, but, because of transportation difficulties growing out of World War I, blends of American clays were developed which have been utilized since that time with equal or better results.

Organic suspending agents, such as gum arabic and gum tragacanth, are sometimes used to increase the bisque strength of the dried slip. Bentonite is employed in small amounts in some mill additions because of its excellent suspending properties, but it has other characteristics which militate against its use by itself.

Electrolytes. Small amounts of one or more water-soluble salts called electrolytes are included in the mill formula. They cause flocculation of the clay, and thus the suspension of the finely ground particles of frit, and the workability of the slip can be closely controlled. An electrolyte must be chosen carefully on the basis of its reaction with the clay and its effect on the properties of the finished enamel.

Setting-Up of Enamel Slips. After an enamel slip has been milled and aged it is seldom in exactly the correct condition for application to the metal in so far as the specific gravity, mobility, and yield value are concerned, and therefore it is necessary to make certain adjustments at the tank in the case of dipping or in a storage container if the enamel is to be sprayed. This adjustment, called "setting-up," involves the addition of the correct amounts of water and certain chemicals, as the result of which the enamel slip will flow easily on the surface of the ware, drain evenly, and set to form a layer of the desired thickness. The chemicals used for this purpose are known scientifically as flocculants, but in ordinary practice they are called "setting-up agents."

If the attempt is made to dip ware in ground-coat slip in its primary condition, the slip may be so thick and viscous that it will drain in streaks. If sufficient water is added to prevent this occurrence, the draining may be good but insufficient enamel may be left on the metal surface. The addition of a flocculant is therefore necessary. Such substances act upon the clay holding the enamel in suspension and on the very fine particles of the enamel itself in such a way that the slip is thickened. After the enamel has been set up sufficiently, water may be added to make it flow properly. The set can be broken by the addition of too much water and therefore a nice balance between draining and setting must be reached, a factor which depends to a considerable degree on the skill of the operator. In some plants each dipper is allowed to set his own enamel as required, but in the larger and more progressive shops the operation is placed in charge of a control man who examines the slips at regular intervals and makes necessary adjustments.

The principal setting agents for ground-coat enamels are borax, magnesium, potassium or ammonium carbonates, and sodium nitrite. Borax is most generally used, but if the ware tends to rust badly small amounts of ammonium carbonate or sodium nitrite may be employed.

Cover-coat enamels are usually set up with a small amount of magnesium carbonate or other flocculant as a mill addition. It is seldom necessary to add additional setting-up agents to cover-coat enamels, but in such a case, which occurs more often in connection with dipping than with spraying, the indicated agent is potassium carbonate or sodium nitrite in saturated solution.

OPACIFICATION

The opacity of an enamel is caused by the diffusion of light by reflection, refraction, and diffraction of impinging light rays by particles embedded in the glass matrix. Light is reflected from both the enamel surface and the suspended particles, the crystals and smaller particles producing the greater diffusion. Where light passes from a medium of one density into another medium of different density, light rays are bent or refracted and the direction of propagation is changed. Thus, in enamels in which a number of substances of varying index of refraction are present, the light rays are so mixed that diffusion results. The more interference the light rays meet in passing through the glass, the greater will be the diffusion and therefore the particles of opacifier should be highly dispersed and of irregular shapes and sizes. The character and amount of opacifier present and the thickness of the enamel layer are the factors which have the greatest influence on the final opacity, which is customarily measured by the degree of reflectance of light from the enamel.

For many years the opacifier most generally used in white cover-coat enamels was tin oxide, 10 to 20 per cent of which

was added at the mill. To insure the required degree of opacity in the finished enamel two or more applications of the slip were necessary and because of the considerable thickness of the enamel layer (0.016–0.020 in.) the tendency toward chipping was accentuated. While tin oxide was satisfactory from the standpoint of performance, its cost was relatively high, and strenuous efforts were made by manufacturers to produce an opacifier possessing the good qualities of tin oxide at a lower cost. From time to time satisfactory opacifiers having as their bases the oxide of titanium, antimony, or zirconium, either alone or in combination with more basic oxides, have been developed.

An interesting improvement was achieved when it became the practice to render the clear frits then in use more opaque by the introduction of antimony oxide or sodium antimonate, and thus less tin oxide had to be used in the mill addition. More and more antimony was employed in the frit and less tin oxide in the mill until it was possible to attain good opacity in thinner enamel layers (0.012–0.015 in.) and thus to decrease the chipping tendency at the same time.

As has been pointed out, the fine grinding of enamels produces a definite increase in opacity, but it has been found that finer enamels show greater tendency to tear in firing. This unfortunate characteristic is overcome by the addition of sodium nitrite to the slip, and so, by the addition of 6–10 per cent of opacifier to an already highly opaque enamel frit and fine grinding, it is possible to reduce still further the thickness of the enamel layer and the tendency toward chipping.

A still greater improvement is brought about by the replacement of antimony oxide in enamel frits by zirconium oxide. Antimony oxide does not dissolve appreciably in the glass, and the viscosity of the latter increases as the content of antimony oxide increases, thus placing a limit on the antimony content in relation to workability. Where zirconium oxide is present, on the other hand, the enamel melt is clear at temperatures above 1400 F, but in a cooled condition it becomes very opaque because of the crystallization of a zirconium silicate complex. Thus the glass retains a high degree of homogeneity and workability while it is hot, and the final opacity is developed during cooling after the enamel has been fired on the metal to such a degree that the use of any considerable quantity of opacifier at the mill is unnecessary. Such enamels make possible the highly desirable single-coat application in relatively light weights (0.008–0.010 in.) which lowers the cost and the chipping tendency; and they are also harder and have a higher gloss than the antimony-containing enamels, although they have inherently a lower degree of acid resistance.

Probably the most important improvement in the opacification of enamels has been developed since the end of World War II by the introduction of titanium dioxide into the enamel batch. Titania behaves in the same manner as zirconia in that it dissolves completely in the fused glass. Where it is cooled rapidly the frit remains clear, but on reheating to enameling temperature the titania precipitates and produces opacity of high degree. This opacity is caused by the greater difference between the very high index of refraction of titania and that of the glass matrix. The opacity is so high that an enamel layer of one half the thickness has a reflectance equal to that of a zirconia-opacified enamel. The acid resistance of titania-opacified enamels is almost perfect. At present these enamels are used extensively on refrigerators, stoves, and other wares which require a high degree of acid resistance.

COLORS

The materials used for coloring enamels, which are added at the mill, represent a wide range of possibilities, almost any color being available. The frits used for making colored enamels fall into three groups; colored frits, white opaque frits, and transparent or nearly transparent frits. The dark colors, such as blues and blacks, especially for ground coats, are made from colored frits, pastel shades from white opaque frits, and opaque colors from semitransparent frits.

Pure color oxides, such as those of cobalt, chromium, nickel, and iron, are not generally employed as mill additions because they cannot be easily distributed uniformly in the enamel. They require excessive grinding and produce a weaker color in proportion to the amount added than where they are used as color oxides, which are calcines of mixtures of pure color oxides and frits. Usually the enameler leaves the manufacture of colors to concerns that make a specialty of the art.

ENAMELING IRON

The quality of the sheet iron or steel to be enameled is of the highest importance inasmuch as many of the troubles associated with enameling have been traced to the metal. In the early days when the function of the metal was not well understood, there was considerable warpage, and the impurities produced such defects as "copperheads" (penetration of iron oxide through the enamel), blisters from gas inclusions, and fish scaling (also caused by gas evolution). The problems involved in the elimination of these defects have been studied seriously by steel companies in their efforts to produce metal having the proper chemical composition and physical qualities to insure both workability and enamelability. By excellent metallurgical research, continuous improvement in the quality of enameling iron has resulted. These problems are difficult because the properties of the iron and of the enamel must be coordinated carefully in the face of a considerable difference of opinion in regard to the fundamental theory.

The early irons were fairly high in carbon and metalloids, but it is now considered that lower carbon and a higher degree of purity are essential. Many steel mills have produced good enameling irons, of which several possess unusually good enameling characteristics. Chemical control has been worked out to the point that poor enameling qualities usually can be detected in the rolling mill.

The fundamental chemical requirements are low carbon, not over 0.1 per cent, and low metalloid content. The metal should be free from solid and gaseous impurities which might cause blistering and other surface defects. The sheet should not warp, sag, or otherwise be deformed when properly supported at enameling temperatures (1400–1600 F). It should have good gas and electric-welding properties. There should be no lamination, slag inclusions, or gas pockets. The drawing qualities should be well adapted to the forming of ware by stamping and spinning. The surface should be especially suitable for enameling.

Within the past few years, research on enameling iron has produced a new type of sheet which, while conforming with the low carbon-low metalloid requirements, contains 0.20–0.50 per cent titanium. It has excellent mechanical properties, but for the enameler the most important characteristic is that it requires no ground coat, although a carefully controlled nickel flash should be applied to the metal to insure satisfactory bond. Cover-coat enamels applied directly to this metal have excellent adherence and resistance to mechanical failure, and are free from the usual defects caused by gas evolution.

Enamelers have not standardized any particular surface characteristics from the metallurgical point of view, but they are agreed that the removal of oil, grease, and drawing compounds must be accomplished easily and that, after pickling, the surface will be such that the pickup of enamel shall be uniform. As little gas as possible should be evolved in the firing of the enamel.

The type of steel surface and freedom from strains are to a large extent controlled by the rolling procedure and heat-treatment in the steel mill. Strains may be introduced during fabrication of ware, but those which cannot be eliminated by proper design can be removed or minimized by suitable annealing.

With the advent of thinner enamel coatings the gage of metal used in the industry has gradually been reduced so that, whereas in earlier practice 18-gage metal was employed, it is now customary to use 20 or 22-gage sheet for refrigerators and stoves, and 12-gage for bathtubs.

PREPARATION OF SHEET-METAL SURFACES FOR ENAMELING

Sheet iron passing through the fabrication operations of an enameling plant—stamping, drawing, spinning, and welding—will of course pick up oily substances and oxidize to some extent. Obviously, such contaminants must be removed completely before the ware can be enameled successfully. Three methods for the removal of oil and grease from sheets of ware are in general use, i.e., scaling, sandblasting, and chemical cleaning. Oxide is taken off by pickling.

Scaling. The ware is heated in a muffle furnace at 1200–1300 F until all organic matter has been burned off, an operation which may require from 1 to 3 min, or longer, depending upon the amount of oil present and the charge placed in the furnace. Care must be taken to prevent overheating which might cause warping. The method is efficient but relatively expensive. It was formerly much more generally used, but today finds its chief application in the treatment of pieces having deep draws, roll edges, or flanges, in which cases the cleaning is accompanied by annealing to release the strains, and thus improve the enameling qualities of the ware.

Sandblasting. This process is relatively unimportant for the sheet-steel enameler because it can be used only with the heavier gages of sheet steel—14-gage or heavier. Much care must be exercised in regard to the air pressure lest the sand strike the metal too hard. Unfortunately, oil and grease cannot be removed in this way, and the ware first must be cleaned by scaling or by chemical treatment. The chief application of sandblasting in sheet-steel enameling is to remove enamel to reclaim expensive fabricated shapes that have surface defects.

Chemical Cleaning. Organic solvents, such as naphtha, gasoline, kerosene, or benzol, may be effective in the removal of oil and grease, but are seldom, if ever, used in cleaning ware to be enameled. Such solvents are expensive, the fire hazard is great, and a thin film of solvent remains adsorbed to the metal to which the water-suspended enamel will not adhere.

The cleaning agents in almost universal use are alkalies in water solution. The compounding of substances of this type has been the subject of considerable research and development, as a result of which a number of thoroughly satisfactory cleaners are available. Basically, cleaners contain such alkaline materials as sodium carbonate, sodium hydroxide, borax, sodium phosphate, sodium silicate, and sodium cyanide, the last mentioned representing the most recent development. Cleaners are dissolved in water to produce concentrations recommended by the makers on the basis of the results of many practical tests. The solution is used at boiling temperature, the higher the better.

The cleaning process is obviously effected by the alkali content of the cleaner. This alkali accomplishes emulsification and saponification of the oils and fats, which are usually of animal or vegetable origin. Mineral oil is not saponified, but the presence of soaps aids the emulsification by which its removal is achieved.

Pickling. In the pickling operation, iron oxide in the form of scale or rust is removed from the ware by treatment with hot (150–160 F) dilute sulphuric acid or cold hydrochloric acid in which the oxide dissolves. Sulphuric acid is employed in a concentration of about 6 per cent, and hydrochloric acid at about 11 per cent. The acid attacks the metal to some extent and the hydrogen thus produced tends to push the scale off the surface. A proper degree of etching is advantageous in that it improves the pickup of enamel slip. The time of pickling is usually from 10 to 20 min, depending upon the concentration of the acid, the temperature, and the amount of scale to be removed. Care must be taken to avoid too-high concentration of acid as well as temperature because of the tendency of iron to absorb the hydrogen generated in the reaction, which in the firing of the enamel will be released and cause blistering. Moreover, a greater depth of etching is produced, and, in dipping, the roughened surface tends to pick up more enamel than is desirable and may cause trouble in firing. Obviously, the correct concentration of acid should be carefully controlled between known practical limits.

Rinsing. After both the cleaning and the pickling operations have been completed, the ware must be thoroughly rinsed in running warm water to remove adhering alkali or acid whose retention would cause trouble and also to prevent carry-over which would add to the expense of metal preparation. Recently the use of sodium cyanide in the afterpickling rinse water has been proposed because of the effectiveness of the salt in removing harmful sulphates and chlorides. The cyanide removes smudge and also tends to improve the draining of ground coat.

Neutralizing. In order to make doubly sure that no acid is carried along by the metal, the ware is immersed in a hot (150–160 F) dilute (0.3–0.4 per cent Na_2O) solution of the neutralizing compound, which may be 90 per cent soda ash and 10 per cent borax or these salts with sodium phosphate. Neutralizing compounds are also made especially for the purpose and the proper concentrations are established by the manufacturers. The time of the neutralizing operation depends largely upon the conditions present. The concentration of the neutralizer must be under close control. If the solution is too strong, the salts will dry on the ware and cause trouble with the enamel later. If it is too weak, the acid will not be neutralized completely and will lead to defects in the firing.

Drying. After neutralization the ware is allowed to drain, and then it is placed in a hot drier with a good circulation of air in order that water may be eliminated so rapidly that the metal has no chance to rust. Properly prepared metal has a straw or golden-brown color.

Nickel Dip. In some plants, and the number of them is growing, a nickel bath is placed in the pickling line following the acid rinse. The bath contains nickel salts and boric acid at a hydrogen-ion concentration between 3.2 and 3.5, which must be carefully maintained. The temperature is 160–180 F. The ware is left in the bath from 5 to 15 min, in which time the nickel plates out on the iron electrolytically. The nickel flash is efficacious in increasing adherence and preventing fish scaling.

THE ENAMELING PROCESS

Application of Enamel to the Ware. Enamels are usually applied to the metal in two or more coats, each coat being fired before the next is applied. The first coat is called a ground or grip coat and generally contains a small amount of cobalt, nickel, and manganese oxides which increase the adherence of the enamel to the metal. This coat fires to a deep-blue color. The enamels for the subsequent coats are so formulated that they adhere one to another although they would not by themselves adhere well to the metal. They may have any color whatever. The number of coats required depends upon the opacity or covering power of the enamels used as cover coats. White

enamels were formerly applied in two coats, but in the most modern enameling practice satisfactory results are obtained by the application of one cover coat.

Enamel may be applied to the metal by dipping the ware in the slip and allowing the excess to drain off, or by spraying the slip on the metal by means of a gun operated with compressed air. Sheet-iron ground coats are, in general, applied by dipping or slushing; in the first method the enamel drains by itself, and in the second the ware is rotated and shaken at the same time. Cover coats may be applied by dipping if the ware is to be covered on both sides; but if only one side is to be coated, the enamel is usually sprayed. Hollow ware must of necessity be dipped, and a high degree of skill is required to produce an evenly distributed coating of the specified thickness. Ware to be dipped may be held in the hands directly or with tongs. In the latter procedure the tongs have to be designed for the particular shape that is to be dipped. In either case the piece is dipped in the enamel and then is rotated and shaken simultaneously to eliminate excess slip and bring about even distribution.

Drying. After the ware has been sprayed or dipped it must be dried carefully. This operation is carried out in several ways, depending upon heating to a suitable temperature, usually low, in rapidly circulating air, which may contain some moisture by which the speed of evaporation of water from the enamel is controlled.

The most desirable condition for drying enamels is the application of heat to the back of the ware so that the enamel has no chance to dry on the surface first. This procedure is of course impossible in the case of hollow ware, which is necessarily coated on both sides. If the enamel is dried rapidly either by the direct application of heat or by the circulation of heated air on the surface of the enamel, there is a tendency toward a surface drying while the under enamel remains quite wet. The shrinkage of the enamel then takes place at different rates in different layers and many fine cracks are formed which may result in tearing in firing. Drying difficulties can be avoided to some extent by the use of a high clay content and coarse milling, but a more uniform coating, more easily applied, and a better gloss are obtained if the clay is kept to a minimum and the milling is somewhat finer.

The drying operation may be performed in drying rooms heated by steam pipes, but this practice is less efficient than the use of the continuous drier, which makes possible closer control of drying conditions, greater uniformity of drying, and less handling of ware.

Firing. The final manufacturing operation in the production of enameled ware is the firing, during which the dry enamel is fused on the metal to form a continuous, smooth, glossy coating. Two types of furnaces are used, namely, the box furnace which is operated intermittently, and the continuous furnace. They are muffles heated by gas, oil, or electricity. The requirements for successful firing are comparatively simple—proper temperature and time, proper support of the ware in the furnace, uniform heating and cooling of the ware, and a furnace atmosphere free from sulphur fumes and water vapor.

Firing time and temperature depend upon a number of factors, such as thickness and uniformity of the metal stock, thickness of the enamel coating, fineness of the enamel, ratio of the amount of ware to reserve heat in the furnace, weight and construction of the firing tools, position and shape of the ware, amount of preheating, and radiating properties of the furnace.

The ware must be supported in the furnace in such a way that it cannot become distorted. The supports are made from heat-resisting iron alloys which do not warp nor scale at temperatures used in enameling, and they are designed in relation to the weight of the ware to provide good thermal efficiency.

Uniformity of heating and cooling of the ware is important in preventing chipping, warping, and cracking. The rates of heating or cooling matter little except in so far as these rates affect uniformity of heat distribution, because the sections of the ware are relatively small. The temperature at which ground coats are fired varies from 1500 to 1600 F, and the time from 1 to 4 min; for cover coats the temperature is lower, 1450–1550 F, and the time is shorter. It has become common practice, when the continuous furnace is used, to fire ground-coated and cover-coated ware at the same time, a procedure which has been made possible by suitable modification of the ground-coat and cover-coat compositions. At present, enamels are being formulated to make possible a reduction in firing temperatures in order that warping may be inhibited and that lower costs may be effected.

The atmosphere of enameling furnaces must be free from dust and dirt which might spot the ware. Sulphurous gases in very low concentrations are sufficient to cause scumming of some enamels, and they will discolor enamels containing lead. Water vapor may cause severe blistering.

In addition to the actual fusion of the glass, many physical and chemical changes take place in the enamel-iron system during firing. In the drying of the ground coat, the water present oxidizes the iron to form ferric hydroxide on the surface. In the early stages of the firing this compound is changed to the black oxide and, as the firing proceeds, it dissolves in or combines with the enamel glass. Gases are evolved through the surface of the enamel, after which the glass melts down to a smooth layer containing many small gas bubbles. These gases probably originate in the surface of the iron and from reactions between the enamel and the iron at the interface and perhaps from the glass itself. Such gases as hydrogen, water vapor, carbon monoxide, and nitrogen have been detected. The prevention of excessive evolution of gases from the iron has been the reason for much of the research that has been conducted on the production of good enameling sheets. The underlying theory has been the subject of a great deal of discussion by metallurgists and chemists interested in enameling.

Concurrent with the fusion of the coating to a smooth glassy surface, a high degree of adherence between the enamel and the iron is established. The actual mechanism of the reactions involved has been much investigated but is still in the controversial stage. The oxidation of the iron seems to be an important factor, and in the presence of cobalt, nickel, manganese or antimony, which act as oxygen carriers, appears to promote adherence. Cobalt is generally used in ground coats because it has the greatest effect in this direction. According to one theory, adherence is related to the formation of metallic dendrites which from x-ray research appear to be alpha-iron. These dendrites form a layer between the iron and the enamel and sometimes project quite far into the enamel layer, thereby aiding adhesion, as shown by the fact that when the dendrites are absent the adherence is poor. Another theory is based on the fact that all the metals between iron and copper in the electromotive series, if dissolved in glasses, are plated out of solution when they are fired in contact with iron by the electrolytic action of the hot iron base. Cobalt, nickel, and antimony thus promote adhesion, and the plates of these metals adhere tenaciously to steel while enamel does not. The coefficients of expansion of these metals are intermediate between those of iron and produce a gradation considered to be highly desirable. A certain amount of mechanical bonding is attained by the formation of dendrites and any pits and projections which may be present. According to a very recent theory, the enamel glass is rigidly held to the iron by an extremely thin film of a ferrous phase which is mutually soluble in alpha-iron and glass.

The firing of sheet-iron cover-coat enamels does not involve

as many changes as that of the ground coat because there is no interaction with the steel. The cover coat merely fuses into the previously fired ground coat. The contact surface between the two coats consists of an interfusion of the two enamels which presupposes that they must wet each other. The ground coat preferably has a slightly higher firing temperature than the cover enamel in order that the phenomenon of reboiling may be inhibited.

"Reboiling" is the term used for the evolution of gases which takes place on reheating a sheet-iron ground coat. The two coats must have similar physical properties, such as thermal-expansion coefficients and strength, so that they will retain their intimate contact on cooling.

The cover enamels are melted down to a smooth surface and, if properly fired, have a high gloss and pleasing color and opacity. Colored cover enamels are often sensitive to reducing gases because of their content of reducible color oxides. Temperature also affects color; therefore, the firing of colored enamels requires careful temperature control.

PROPERTIES OF ENAMELS

The properties of enamels fall into two general classes—those that pertain to workability and the fabrication of the ware, and those by virtue of which the finished ware is suitable for the purpose for which it was manufactured. The first set of properties is of primary interest to the enameler; the second set establishes the value of the product as an article of commerce. The enameler is of course responsible for the attainment of the best possible result in each case. To that end many tests have been devised, most of them by the co-operative effort of the National Bureau of Standards with the American Ceramic Society and the Porcelain Enamel Institute.

Thermal Properties. These properties include "fusibility" and "fluidity," which determine for the enameler the firing procedure that he must use; "thermal expansion" and "contraction," of interest to the enameler because it is on the basis of these properties that the enamel is made to "fit" the iron or steel to which it is applied, and to which it will not adhere if the difference between the coefficients of expansion of the iron and the enamel is too great; "resistance to thermal shock," of less interest in fabrication than to the user, especially in the case of kitchen utensils; and "thermal conductivity," a property to which little attention has been given, but which is becoming more and more important, as the use of enamels in the building industry increases, from the standpoint of its value as an insulator.

Optical Properties. Opacity, color, and gloss or brilliance are extremely important to the user from the viewpoint of beauty, and to the enameler because he has to keep these properties under most careful control. In the early years of the industry comparisons were made by the eye alone; but more recently the spectrophotometer, color analyzer, and reflectometer have been adapted to the needs of the enameler, who is depending upon them to an ever-increasing extent.

Physical and Mechanical Properties. The ability of the enamel to adhere to the metal, by whatever mechanism it is explained, is probably the most important property from the standpoint of utility. On this property depends resistance to chipping by impact or distortion.

Hardness is also important because upon this property rests resistance to defacement by scratching or abrasion. Complicated tests have been devised for the measurement of this property.

The elasticity of enamel has not been investigated to any great extent, but it is obviously important from the standpoint of resistance to chipping by bending.

The mechanical strength of enamel, tensile, transverse and compressive, has little significance in the usual sense because structurally the metal base is the predominant factor.

Electrical Properties. The electrical properties of enamels have been given considerable attention in recent years. In general, it can be said that enamels have relatively high dielectric strength and can be used in electrical equipment as insulators. For example, a process has been developed whereby the insulating layers employed in small capacitors are made from enamel, and they are said to be more uniform and reliable than the best grades of mica.

Chemical Properties. Resistance to attack by acids and alkalies as well as by water is the most important of the chemical properties of enamel because upon it depends the usefulness of the material in cooking utensils, refrigerators, and food containers. The allied property of weather resistance is important in such applications as signs and building exteriors.

USES OF PORCELAIN ENAMEL

Porcelain enamel falls into the category of protective finishes for iron and steel along with paint and lacquer. It is easily equal to or superior to the latter from the standpoint of beauty, and in many of its applications it is many times more permanent. Porcelain-enameled ware combines the strength and stability of steel with the beauty and utility of glass.

Commercially, its use has been extended in many fields because of its appearance and cleanliness. It has long been accepted as a finish for kitchen utensils and hospital ware. As the technology involved in the forming and welding of sheet-iron shapes and the application of enamels to shapes of large size and complexity was developed, the field of household appliances was invaded, and today the manufacture of table tops, refrigerators, stoves, washing machines, sanitary ware, water heaters, and similar equipment is a mass-production industry. It is also coming into widespread use in wall tile for bathrooms and dairies; also in so-called curtain wall construction in large buildings because of its fireproofing and insulating qualities.

In outdoor applications it is used extensively in the manufacture of signs, transformer tanks, and architecturally for houses (Lustron), store fronts, and filling stations. Because of its high resistance to abrasion, enamel is giving excellent service as a protective coating for coal and grain chutes and conveyers.

In the chemical and processing industries it is used as a protective coating for reaction and storage vessels and pipe.

In some applications enameled bearings give excellent performance. During World War II enameled iron replaced critical stainless steel in airplane exhaust stacks. Enamel is used extensively as a coating for wire-wound resistors and as the insulation in capacitors.

Because of its bright attractiveness, appropriate colorability, easy cleanability, and high degree of durability, porcelain enamel is assuming ever-increasing importance in the merchandising field and as a material of construction. Assuredly it is an outstanding contribution of ceramic science, technology, and industry to the requirements of better living.

ACKNOWLEDGMENT

There is a voluminous periodical literature of porcelain enameling, from which the author has drawn freely in the course of his experience. Among the books, "Enamels," by Dr. A. I. Andrews (Twin City Printing Company, Champaign, Ill., 1935) and "A Manual of Porcelain Enameling," edited by J. E. Hansen (The Enamelist Publishing Company, Cleveland, Ohio, 1937) have been found most informative. Particularly helpful in the author's researches in this field have been the close co-operation of and the practical aid by specialists of his fellowship donor, the O. Hommel Company of Carnegie and Pittsburgh, Pa.

BUILDING *an* EXECUTIVE RESERVE

By FRANK J. KOEGLER

EXECUTIVE VICE-PRESIDENT, DOEHLER-JARVIS CORPORATION, NEW YORK, N. Y.

A SOUNDLY managed business must be prepared for the proper replacement of its principal executives. This preparation must take the form of a carefully nurtured executive reserve. The absence of such a reserve invites crises and uncertainty, resulting in great disruption to the business operation.

On the tried and proved theory that any business is as good as its management, it is obvious that it is most important to have ready an executive reserve or a secondary line of defense. This is the task not only of the principal executive officer, but the task of every executive in an organization. Every executive must be encouraged to train his successor, and he must be taught fundamental reasons for doing so.

Most everyone will agree that no executive should be promoted unless he has a trained understudy to take his job. We should, however, also admit to ourselves that the opportunity to be chosen for a higher position depends upon the knack of developing good assistants. Therefore, looking at it objectively, the executive who has demonstrated his ability to select and train future executives has established his qualifications for promotion. Therefore it is of primary interest to the executive himself to build an executive reserve.

Unfortunately, when the average industrial businessman stops to examine his executive-reserve-building activities over the past 15 or 20 years, he too often finds an absence of the vision required to maintain a continual executive-building program. Much too frequently, we find presidents and vice-presidents of companies who are solely specialists both by training and experience. The top posts call, rather, for persons with broad backgrounds, who are acquainted with all phases of the company's operations. This has been one of the important discoveries in the program of our company.

When we take an over-all view of business, we realize that we are facing a new situation. Our society is growing older. Some 2700 U. S. citizens reach the age of 65 daily. Company executives are also growing older and many are close to retirement age. When these significant facts are applied to a particular organization, startling problems that have to be dealt with and dealt with immediately are presented. Most of us, undoubtedly, can see this challenge. We realize that in the long run the business team will be as strong as its reserves rather than as strong as its individual stars. Our basic problem is the proper development and guidance of the reserves.

THE SECONDARY LINE OF SUPERVISORY DEFENSE

Building a secondary line of supervisory defense has always been one of the key interests of the executive committee of our company. We have always been vitally concerned about the oncoming youngsters who show a knack for planning, supervising, and executive management. These are the strongest youngsters who can be molded and who welcome the opportunity of training with long-range objectives in mind. We have found, surprisingly, that the so-called weak man, rather than the strong man, is more likely to resist the idea of training and development.

Over the years the front-line gaps in our organization have been filled in two ways: (1) Mr. Doehler, recognized as the man who has contributed more to the die-casting industry than any other person, has constantly sought alert, level-headed, and ambitious associates and employees. (2) The organization has throughout its more than 45 years of existence continually pioneered—developing new applications for die castings, opening new factories, adding to older factories—and, as a consequence, has always trained additional supervisory personnel.

Our organization is much like other companies when it comes to spotting men for promotion as supervisors and potential executives. We know a good supervisor when we find him and see him at work. We know what kind of experience to put a prospective supervisor through to develop his leadership skills provided he has the capacity to acquire and use those skills.

The heart of our problem in selecting men for reserve-leadership positions is found in the answers to these questions: How do you find out beforehand what kind of potentials any individual has? How can you know in advance that he will grow and profit when you give him sound supervisory training? Once we have found that man we do not cast him aside the first time he makes a mistake. We merely impress upon him the absolute necessity of following the old principle of not repeating mistakes.

Let me illustrate what I have in mind by something that happened to us about three years ago. We selected a man in his middle thirties to groom him to take over a highly responsible position which we knew would be vacant in about four years because of the forthcoming retirement of a senior department head who had been with us a long time. The younger man had a substantial record of achievement in the armed forces in the type of work he undertook with us. He had good technical training and his family background indicated stability of character. By the same methods which enabled us to choose some excellent men in the past, we hired this man.

Before long his superior claimed the recruit in his office did not have what the job required. Eventually, his superior became more insistent. He said the man could not measure up to responsibility. Finally, the supervisor curtailed this younger man's work to mere clerical tasks.

The facts somehow didn't fit together. Naturally we leaned to the superior's conclusion but one factor gave us pause. The supervisor was a man who took pride in his own show and while he handled it with high efficiency, he ran it—and ran it alone. We questioned whether or not the supervisor was giving the younger man a break—teaching him what he ought to know—or, on the other hand, if he was inwardly resenting that someday soon the younger man would take over his job.

At this point, possibly by luck, we began to find an answer to this question. It is the kind of answer of which many executives are skeptical—including some in our own organization—for it is frequently difficult to overcome long-standing habits of thought. The final decision was important, for a considerable outlay had been made. If the supervisor was right about the recruit, we were a year behind in the program of developing a successor. Furthermore, if we had to pick a new candidate, all we had to go on was the same method of personal impressions to judge a man's ability and personality.

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It must be emphasized that pooled impressions of several supervisors and executives had not helped in the case of the young man referred to. A psychological report, however, made without benefit of an interview with the young man and without a record of his work history, revealed in sharp accurate detail a pronounced tendency to evade responsibility for his mistakes. After reading the report, the superior remarked: "Why, this sounds as if the psychologist had been working with this young man for a year just as I have." We thus learned that our consulting psychologists by use of their testing procedure in just a few days could forecast accurately a man's job behavior, whereas we required many months to attain the same result. On the basis of such corroborating information, we were confident we could make a fair and practical decision. We immediately decided that further tryout for this young man would serve no good purpose and so we gave him help to find another position.

THE QUALITIES OF LEADERSHIP

In looking for the executives of tomorrow, we can readily make an effective appraisal of a man's technical background. Most of those who do not make the grade stumble for other reasons. In weighing and considering executive material in the past years, I have had to ask myself many questions. Can this man accept responsibility and carry it? Has he the physical drive to keep on top of his job? What capacity does he have for long-range thinking even though he is able to make spot decisions? Can he handle a group in a way that gains the confidence of subordinates? Can he lead and be firm rather than dictate? Can he define authority and delegate it? Can he take orders? Can he contribute co-operatively to the management team? Can he train and instruct new employees? Does he have the awareness found in men who can recognize that each subordinate is a unique individual and seek to develop the potentials of each accordingly? Can he give praise where praise is due? How about his integrity, fairness, and dependability?

We were able to obtain practical, usable answers to questions like these by a combination of our own observations and the aid of our psychologists. These answers were highly important, for they enabled us to predict the job behavior of men we were considering for promotion to top-flight responsibilities. We do not say the predictions have been absolutely perfect but they certainly have enabled us to feel greater confidence in the selection of men for larger responsibilities.

THE PSYCHOLOGISTS' CONTRIBUTION

The contribution of the psychologists is real and substantial. While their method of analysis is not entirely clear to me, their tests and answers certainly seem practical. They give us a comprehensive description of a whole person—what he likes to do, what his motivation is, what level of responsibilities he is equipped to carry, how he reacts to supervision, whether he has leadership ability, whether he leads or throws his weight around. They tell us, too, what kind of a man he is to work with, what upsets him, how slow or quick to anger he may be, whether his tempo is fast or lethargic, what his work habits are like, whether he needs to be followed up or gets going on his own initiative. They also give us important clues about his sense of team loyalty and his potentials for growth. These descriptions, which coincided time after time with our own knowledge of our employees, together with important data and conclusions we had not seen, brought home to us the practical effect and worth of these evaluations.

Let me make one point clear. While our psychologists did not have to make a testing survey of our men before they could appraise their abilities for foremanship, sales engineering, or some other job, it was necessary to give them detailed information about job requirements in our company. They used, for the most part, the job descriptions developed for our salary-evaluation program.

PERSONALITY TESTS

Another real contribution of the psychologists lies in their ability to devise new tests of personality which, somehow, enable them to tell us what a man will be like on the job day in and day out. The detail of their descriptions seems uncanny at times, and it helps us to place men where they have a chance to succeed. This, of course, helps the individuals involved, for no man profits as much from going down a blind alley as he does from starting down a road where he has a chance to utilize his abilities. However, we have not permitted these test reports to prevent us from offering opportunities to men we felt certain had ability to advance. These psychological evaluations, however, have enabled us to open more doors of opportunity to our men than we previously thought was possible. What appeals to us most is that we receive practical appraisals of men's potentials which we can use more readily.

In our executive-reserve development program we have never attempted to solve these problems by any black magic. We have looked at modern concepts and tested them in the crucible of everyday work. We have used psychological reports that contained job facts relative to business and industry, that set forth conclusions drawn from long years of dealing with various types of personalities—in brief, reports that revealed much about human nature on the job.

What we have discovered, then, may be summarized in this way. Our business is to produce die castings in quantity efficiently and profitably. In the course of 36 years with the company, I have seen it grow and grow from a mere handful of leaders and hard-working employees who had faith in the new process of shaping molten metal. We feel that we know our business—that we make the best in die castings. We have established policies that cultivate high morale and co-operation among our entire staff of employees. In essence, these results have been achieved through men who have developed leadership ability—the ability to inspire diligence and co-operative effort. But like other firms, we have had too many individuals fail as supervisors before we found men who were successful leaders. The reason was that our information about those individuals was incomplete. With outside psychological assistance we have been able to gather more dependable, objective, and useful information than we ever had before.

We feel that in this way we have obtained useful results in backing up our front-line executives and supervisory personnel with men who are equally good and in some cases even better.

CONTINUAL SEARCH FOR EXECUTIVE RESERVES

The problem of executive reserves is not new. Without letup we have continually through the years searched and re-searched the ranks of our organization for potential leaders. We have always kept in mind the hard and fast philosophy of our founder, Mr. H. H. Doehler, who many times has said: "The work of a chief executive always lies in the future. To prevent a difficult situation is problem number one, but not to be prepared in case it should happen, would be mistake number one."

It has been our experience that the most effective way to train junior executives is "to let them ride the horse." They will be thrown, of course, they will make wrong decisions, and they will learn even as we all have learned by many hard knocks. No man, however, can ever be a leader if he has been sheltered all of his life, and if he has been accustomed to leaning instead of standing up and facing the realities of life.

Co-Operative Engineering Education at Faculty Level

By W. E. REASER

CHAIRMAN, MECHANICAL ENGINEERING DEPARTMENT, SWARTHMORE COLLEGE, SWARTHMORE, PA. MEMBER ASME

AMERICAN industry may direct attention to an exemplary record of co-operative effort with engineering schools. Exceptionally well-conceived publications continue to be disseminated, mostly without charge, for use by alert teachers who recognize the need for up-to-date technical literature as a supplement to standard texts. Specialists are available to present lectures either to class groups or to undergraduate society meetings. Plant visitations for students to observe theory in practice are encouraged by industry. Opportunities for consultative practice by staff, as well as employment experience for both undergraduate engineering students and teaching corps, have been standard procedures over the years. Scholarships and research grants are other evidences of co-operation.

Such activities are but a few of many forms of co-ordination. Values have not all been to the advantage of the schools—industry has benefited through its fair share of profits resulting from these ventures. For example, summer employment in oft-termed "precadet training" has indicated to the embryo engineer the future job potentialities in a particular organization. On the other hand, industry has thus been able to obtain a "preview" of the capabilities of a prospective employee before the hurly-burly period of senior interviews.

It is within the area of industry-engineering staff relationships that the subsequent comments are specifically aimed. Though submitted as a suggestion for consideration on the part of the vast fuels industry, it is believed that the concept may well have a broader significance.

AN EXPERIMENT IN CO-OPERATION

In the summer of 1946, as a consequence of a series of conferences with an executive of a large industrial establishment, there was inaugurated a program which might well be termed "Co-Operative Engineering Education at Faculty Level." Each of five universities and colleges was invited to select one individual from its mechanical-engineering staff to participate in the developmental test of equipment yet unpublicized.

Some of the objectives of the plan were as follows:

1 A number of engineering teachers representing a variety of colleges and universities—living together, working in the same group, discussing problems not only on the job but over the coffee cups—would provide unprecedented occasion to learn philosophies of others in the same profession. Here should be the chance to acquire new ideas in teaching methods and techniques to take back to the home campus—notions which had been tried and proved successful at other schools. In addition, there could develop discussions of lasting value to the participants, for the entire realm of engineering education, and to industry as well.

2 Such an experience would enable engineering teachers to keep abreast of new developments in their field that they might be more enlightened, more enthusiastic, and more capable instructors in the classroom.

3 An industrial organization could demonstrate the kinds of "postgraduation training" and variety of jobs it provides for the young engineering graduate. Of equal significance, the teachers would learn by actual observation the types of men desired by the company.

4 Closely associated with the aim defined under (3), the professors would work directly with the trainees assigned for a research or developmental test experience in the prescribed company educational program. How useful to perceive and evaluate the reactions of the young men to the training procedures!

5 An important factor, too, was to be the privilege of seeing American industry at work in a way impossible if the professors were simply assigned to specific tasks similar to those of other regular employees. Through active participation in staff meetings and strategy discussions (often over the dinner table), a backstage scene would be unfolded, in general, to reveal a drama unappreciated previously.

6 It would provide a vehicle by which the engineering teachers might relieve the heavy financial burdens under which they struggle. Thus many might remain in their chosen profession, rather than succumb, as has happened too often, to the inevitable job offers ostensibly tied to a pot of gold in place of one labeled "satisfaction."

It is to be emphasized that this is not a discussion pertaining to ordinary summer employment for engineering teachers. Activities of this nature have been and still are somewhat common though they all but disappeared during the depression and planned recession of the 1930's. World War II required complete attention of management and college teaching staffs; as a result, there was neither immediate need nor inclination to provide means for novel co-operative programs of action.

This project was launched in the era following cessation of war at a time of continued expansion of Government as well as private research. Such activities absorbed vast numbers of engineers, including many professors. Simultaneously, industry needs for technical help reached new peaks. Inflated prices subjected staff members to excessive pressures to leave schools for more lucrative industrial opportunities. Yet, at the same time, returning GI's swelled the ranks of engineering undergraduates in the nation's colleges in numbers heretofore unknown. Even students were deputized to instruct others. Those days, 1945–1950, were more befuddled than usual for the engineering teacher, and the future might have been deemed hazy for the engineering schools as well.

Address pertaining to "How Industry Can Co-Operate With and Assist Engineering and Technical Schools in Offering Instruction in Fuels and Fuel Utilization," presented at Symposium on Fuel Engineering Education, Annual Meeting, New York, N. Y., November 26–December 1, 1950, of The American Society of Mechanical Engineers.

Parenthetically, attention should be directed to the situation today. With mobilization for the present war well under way, and estimates of the need both in industry and the armed services for technically trained personnel expressed in figures of astronomical magnitude, a confused state presently exists. (1) The raw material for undergraduate instruction in engineering is in short supply. (2) The demands of the military and those of industry are in conflict—in truth, there are at least two jobs for every able-bodied intelligent man within the present draft-age brackets. (3) Industry and Government continue to "pirate" staffs of educational institutions of their most capable trained personnel, caused particularly by the tremendous salary gap between "town and gown." This practice simply accelerates the drying up of the pool of instructional lifeblood so essential for the continued development and, quite probably, the eventual salvation of this country. Certainly, in any future fighting war, our hope lies in overwhelming the enemy as a consequence of productive capacity and engineering know-how.

PRACTICAL FACULTY-ENGINEERING EDUCATION

In the co-operative program under discussion, most of the ideals were happily realized. Since then, during ensuing summers, there has been a continuing stream of college technical personnel subjected to the influences of this form of faculty-engineering education. At least one other organization is promoting a similar plan. It was the author's privilege to take advantage of a 12-week treatment in the summer of 1948. Three other engineering professors were assigned to the same plant location; an additional thirteen in small groups in several more of the company establishments. All had specific job tasks but they were urged to become completely orientated to plant practices by frequent excursions to various departments. At one time in the summer, the entire group, with invited guests from academic life, making a total of thirty-three, joined with executives and administrative staff at company headquarters for a seminar of one week to discuss problems of mutual concern. Another scheme advanced by the same company makes it possible for a professor to devote an entire sabbatical year in some capacity, such as in research, or on some particular investigation in his field of interest.

APPLICATION TO FUELS INDUSTRY

Further extension of this idea should be encouraged. Specifically, for the fuels industry, this can be an indirect but most profitable method calling attention to the need for an oncoming generation of capable young fuel engineers, and at the same time properly educating in a variety of ways a group of engineering teachers who have uncommon influence on the lives of their students. Education of this nature would prove ultimately to be one of the best forms of undergraduate instruction in fuels and fuels utilization.

At the same time, if this concept is wholesome, all segments of American industry might vigorously sponsor an expanded program. In an address presented several years ago before the National Machine Tool Builders Association meeting at Atlantic City, Dr. Alan Valentine, recently appointed Administrator of the Economic Stabilization Agency, discussed "Private Enterprise in Higher Education." To delineate his thesis, he stated:

"But remember that the average professor knows little of the workings of American business and under the circumstances could hardly be expected to know more; just as many of you may be unfamiliar with the inner workings and mechanics of his academic profession. Even the professor of economics is likely to expound economic theory uncorrected by firsthand experience."

Again, quoting Dr. Valentine:

"There is little that a college can do alone to educate its professors in realistic economics. But there is much that business could do to educate them, to the benefit of both parties and of the private-enterprise system. I have rarely heard a professor of engineering called radical by even reactionary businessmen. Why? Because business uses engineering professors as consultants; takes them into its confidence regarding the company's problems; lets them see how a business must be run; disarms them of absurd misconceptions regarding the selfishness or the low IQ's or the laziness of businessmen.

"In short, business has taken the whole engineering profession into its confidence for very obvious reasons, and engineering professors have by that process gained understanding and confidence in business. The same is true of many professors of scientific subjects, particularly since the war, when businessmen and science professors each learned to place a higher evaluation on the other. It is chiefly the professors of economics, politics, sociology, education, and even literature and history whom I have heard called impractical idealists or dangerous radicals."

Then Dr. Valentine made this suggestion:

"If you could bring college teachers of the social sciences into close contact with the best and most representative business groups, I think that understanding and indeed friendship would be developed far beyond what you might expect. You might not be able to tell from the conversation and appearance which were the professors and which the tycoons!

"If such contacts were made regularly, they would make a great deal of difference. Professors cannot well take the initiative with you, however, but you can take the initiative with them. They welcome you, as a rule, to their campuses. Most professors are human beings and reasonably good fellows. One of them may have married your daughter, or you may have a nephew who is by way of becoming a professor.

"Perhaps I have deliberately overstressed the attitude of businessmen toward professors, but even if I have overstressed it, I think you will agree that business as a whole has done very little to win the real co-operation and confidence of professors with regard to the importance, the fairness, and on the whole, the justice of the private-enterprise system. I have no plea to put before you other than that."

A UNIQUE EXPERIENCE

The two industrial programs to which this argument is primarily devoted provided at least one individual with unique experiences. They have resulted in a consciousness of new horizons which otherwise might have remained indistinct and forever beyond reach. In each case they have renewed a strong conviction of the need for further co-operation between educational institutions (especially that vast number of privately endowed ones) and private enterprise. Conjure if you will the interesting possibilities should each industrial organization (large or small) in this country undertake the objective of educating one college professor by means of a summer association (or during a sabbatical year). No matter what label with which the teacher might be identified—engineering, science, humanities, and so forth—the results of such an experiment appear boundless.

Even in a time of crisis, calm, deliberate, co-operative efforts of groups with mutual interests can shape the future that it may resemble something which is recognized and cherished as the American way of life.

BIG BUSINESS *in* SMALL PLANTS

By D. G. MITCHELL

PRESIDENT, SYLVANIA ELECTRIC PRODUCTS INC., NEW YORK, N. Y.

WHILE the total business of our company is fairly large—$150 millions of sales—our plants for the most part are small, and by that I mean small in comparison with the size of plant we would need were all of our production carried on in one or two plants. None of our factories, however, with the possible exception of one, could be called small if we accept the definition of one hundred employees or less. Because of the nature of our work, it would not be possible to operate in plants of such small size at a cost that would permit us to compete with other manufacturers in our field.

In other words, size is relative not just as to the number of employees or dollars of investment but, what is more important, as to the character of operation. There is a limit to smallness which must be observed if efficient operation is to be realized. A plant too small to use good materials-handling equipment, or to accommodate mass-production devices, would not be able to survive in industries where profits are figured in fractions of a cent. In every instance the minimum size of plant is, to a large degree, determined by the characteristics of the market and product.

Right now, with the exception of one small test-equipment plant, our smallest plant has 230 employees and the largest has 2900 employees. Except for five plants, all of our plants have less than 1000 employees each, hence we manufacture in a great many fair-sized plants although, by comparison with others in our industry, we look upon them as small plants.

POLICY OF DECENTRALIZATION

Breaking the manufacturing operations up into these small plants was deliberate with us, after we experienced the benefits from small-plant management during the war, when we had to turn to a number of feeder plants to help our larger factories take care of a sudden load of war orders many times our prewar production capacity.

We operate under a policy of decentralization of manufacturing wherein the line authority is out in the field and the functional authority stays at headquarters. To state it simply, although the system doesn't always operate exactly that way, the local plant managers run their own show through their respective divisions, while those in the New York headquarters office act in a planning and consultive capacity.

Obviously, there are many things we in New York do for a local manager that he would have to do for himself, or hire someone to do, if he were entirely on his own. For these services the local people are charged pro rata.

While our total business is such that we may be classed as a small large company, our experience has convinced us that small-plant management can accomplish relatively as much, and sometimes more, than big-plant management. In so far as we can see, there are no tools of management that are enjoyed by big-plant management that are not available to the management of small plants. In fact, we see many advantages in small-plant management that very large plants do not as a rule enjoy, such as flexibility, mobility, good employee morale, and executive training through independence and responsibility.

On the social side, there are many advantages in operating small plants. I shall not go into these social benefits here since I discussed them at some length three years ago.[1] Nevertheless, I want to remind the reader that, since management's major responsibility is the efficient production of goods by human beings, the happier employees are, the better foundation there is for effective management.

During the past year our employment has increased almost 50 per cent, partly in new plants but mostly in a rapid expansion of output from existing plants. Under such conditions our attendance and turnover experience has suffered somewhat. Nevertheless, when compared with national averages we come out rather favorably. We think this is exceptionally good when we consider the training problems of our new and expanded plants, and the setting-up problems of new and different facilities and product mixes.

MANAGEMENT PERSONNEL

Probably the most important part of small-plant operation is the management personnel. Small-plant managers have to be good all-round men for the simple reason that the small plant cannot afford an army of specialists. That means that the managers have to know what is going on in every phase of the operation. If they are not good men, inefficiencies creep in and go undetected for a long time and that perhaps is one of the biggest reasons why so many small businesses fail. Our plant managers are expected to be so familiar with their operations that they can spot any leak or any inefficiency before it goes far enough to cause any great damage.

Incidentally, of course, the manner in which they handle their responsibility and the results they secure determine their opportunity to grow into bigger jobs—and they know it. Decentralization as we practice it, provides us with the kind of training we feel is necessary to fill our management-personnel needs.

How well this works out may be seen when I tell you that just four weeks ago we had a top-management meeting in New York which was attended by some fifty men—headquarters and divisional men. The average age of these men was 44 years and the average length of service with the company was 16 years. With very few exceptions all of our management people have come up through the company by this process of management training and selection.

OPERATING A BIG BUSINESS IN A SMALL PLANT

Our experience with small plants so closely parallels that of

Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., November 26–December 1, 1950, of The American Society of Mechanical Engineers.

[1] "Social Aspects of Decentralization," by D. G. Mitchell, Mechanical Engineering, vol. 70, 1948, pp. 532–534.

the contributors to your new book on small-plant management,[2] that I shall follow Dr. Hemple's outline in discussing how we operate a big business in small plants.

Although our plant managers do not have the responsibility of finding the money to finance the construction or enlargement of a plant, they are expected to advise on design and location, and in the case of leased property, to find satisfactory quarters. The decision to lease, or to own is frequently dictated by an examination of capital needs. There are times when the need for working capital overshadows the possible savings from ownership and, at such times it is better to rent than to freeze capital in buildings. This is especially true for a small business that is growing rapidly and needs capital for inventory accumulation and for carrying receivables.

At our recent management meeting, the local management men presented their long-range plans for expansion. We had made some plans at headquarters only to find that the local men, by being closer to the needs of their fields, were out ahead of us. In fact, it is our policy to encourage such thinking and planning on the part of the factory men.

A close working arrangement with a local bank is expected of each plant manager. In most instances our plants are the largest, or among the largest, employers in the community. Our success therefore, means much to all local businessmen and, since the bank is virtually the common denominator of local business, it is important that our relations with it be of the best. It can serve us in many ways.

In choosing a plant location we try to pick a place that not only has the necessary facilities in terms of utilities, transportation, and available labor, but also has a good community character in terms of government, education, growth potential, and kind of people. While we bring in key personnel to new locations, we know from experience that we cannot long continue to provide all supervisory personnel from the outside, if we are to maintain the best community relations. Some places, however, have so far gone to seed, or have had certain work habits ingrained for so long a time, as to make them unadaptable to modern management methods. These places should be shunned by both large and small plants.

COMMUNITY RELATIONS

Our whole philosophy of community relations can be summed up in these words—we want to be neighbors. Simply because we may be a large employer of local labor does not mean that we have to run the town. That's not our business nor do we care to have that responsibility. If the town cannot run its own affairs well it won't be a good town for one of our plants. That does not mean that we do not do our part. As a neighbor we want to do what we are called on to do just as any other good citizen.

We encourage our people to take part in civic affairs as citizens, to be active in charitable drives, in service clubs, and in young people's activities. And that means not only the management and supervisory people, but all the employees. In one plant we had the experience of having one of our machine operators holding the office of mayor, while the plant manager was a member of the town council and it worked out well.

Because we believe in being a neighbor, we do not believe we should take advantage of any community either in terms of wage rates or special concessions. If our tax rates were made especially low somebody else's rates would have to be higher, and sooner or later somebody would be critical of us, and I think justly so.

We like to feel that the payroll we create in a small community helps materially to improve the local economy, but we know that unless we live as a neighbor and good citizen, all the money we bring into that place will not bring the good will we want.

Communities generally like small plants. If the reader could see the mail we receive and the personal calls we get inviting us to establish a plant in some area, he would realize that what I have just said is an accomplishment in understatement.

The Federal Government also wants small plants and, as is well known, through a special office for small business, it did everything it could during the last world war to divert orders to this group. Large manufacturers subcontracted much of their war work to these small concerns. Our own experience in setting up feeder plants, as I have mentioned, was such as to encourage us to decentralize.

PLANNING OPERATIONS

One of the weaknesses of small-plant management has been the absence of planning based on carefully prepared data. The policy of living from day to day, and planning only when there is trouble ahead, is bound to give rise to poorly thought-out decisions. Because there is less margin for error in small operations, it would seem that there must be careful planning both for current and long-range operations.

Much of the planning with us starts out in the divisions and plants. Our job in New York is largely that of co-ordination. We must find the money for expansion, and so we must weigh all the plans in order to get the best investment balance. It is our job also to determine how many eggs we shall put in any one basket and to decide whether we need some new baskets that we do not have.

We have seven product divisions each of which has one or more plants. Within each division are all of the essential functions of manufacturing, sales, and control. Since the responsibility for divisional earnings rests with these product general managers, they are conscious of the need for careful planning. Furthermore, it is just human nature for people to make the greatest effort to make their own plans work.

Obviously, there must be a pattern of local organization for a company with decentralized operations. How that pattern is adjusted to fit local conditions is a matter for local determination. However, there must be organization with well-defined lines of authority and responsibility. Every job must be defined. By delegating authority the plant manager must exercise greater judgment in selecting and training his staff, so that he can use his own time to best advantage. If he has done his job well he will have a better perspective on his operations than if he tries to do every management detail himself.

PRODUCTION YARDSTICKS

In the final analysis the measure of success of any plant is its productivity and cost. We have three yardsticks—standard costs, relation of cost to selling price, and return on investment. Standard costs, which are determined on the basis of experience and measurement, are performance bogies that enable a plant manager to know from month to month how well he is doing, and the reasons for variation from the standard. They thus provide the plant manager with an over-all or general control. Standards, of course, are subject to periodic review to give effect to changes in labor rates and material prices.

Relation of cost to selling price is really the break-even control, while return on investment is the measure of corporate soundness.

[2] "Small Plant Management," edited by E. H. Henipel (under the auspices of the Management Division, ASME). McGraw-Hill Book Company, Inc., New York, N. Y., 1950.

In addition, there is a continuing check of individual operations in the manufacturing process to help a manager to maintain a close control of his costs and quality.

Our series of control may seem elaborate to some small-plant operators but, when we see the results in reduced spoilage and improved costs, we are confident that they pay for themselves many times over. In the past few years, for instance, we have been able in several of our plants to reduce the cost to selling price as much as one third, and we have been able also to reduce greatly the loss from spoilage.

Not only does lessened spoilage reduce costs per unit of output but it also increases the number of salable items that can be secured from a limited amount of raw materials. That, of course, is of major importance at this time.

Legal assistance is given by our legal staff, as well as by local attorneys who are available on call. Our people are encouraged to seek legal advice wherever there is the least doubt, on the theory that it is easier and less costly to correct a mistake before it is made than afterward.

GOOD LABOR RELATIONS

One of the major problems of manufacturing management is that of good labor relations. If everything else were equal between centralized and decentralized operation, we think labor relations alone would tip the scales in favor of the latter. As explained in the paper three years ago,[1] we have found that the managers of small plants are much closer to the employees under them than the managers of a large plant could be. By sort of working and living together a mutuality of interest is built up.

Each of our plants has its own personnel manager who tries to the best of his ability and conditions to hire people as needed who will pull together. Generally speaking, a good job has been done in this direction because we feel that we have a fine group of employees working for us.

The plant chapter of the Sylvania Employees Association handles its own programs for employee social activities. Previously the contributory employee benefits had been sponsored by this association. Within the past few months these benefit programs have been made noncontributory and are now administered entirely by the company.

A vested savings and retirement program to which eligible employees contribute a percentage of earnings and the company contributes a lesser percentage of employees' earnings plus a percentage of profits before federal taxes, has proved popular with the employees.

SALES POLICY

Sales are organized on a related products basis. For some time our sales departments operated independently of the factories under the direct supervision of a vice-president at company headquarters. Within the past year we have placed line authority for sales under the several product divisions because we believe that sales and production must be co-ordinated to achieve the best results. Since manufacturing efficiency is so dependent upon production planning, it is essential that the factories know the short and long-range market requirements and feel that their success depends not only upon how low they can get their costs, but also upon how well they serve their customers.

In other words, after considerable experience with centralized sales control, we have gone back to the more intimate sales operation of a small company. At the same time, however, we have retained the functional supervision of sales at headquarters for general policy, co-ordination, and consultation.

TECHNICAL RESEARCH AND PRODUCT DEVELOPMENT

Technical research is essential to any company that intends to improve its competitive position. A great many companies, however, look upon research as an expense that can be curtailed whenever the going gets a little rough. Unless there is a continuing program of research, it will be difficult to hold research men, and the end product will seldom be available when most needed.

Much of our product development and improvement is done at the division and plant level on a sustained basis. Where there are long-range exploratory projects, as well as certain well-defined projects that will require considerable investment and a variety of talent, we feel they can better be conducted at central laboratories equipped for such purposes. Small companies have the same thing available in outside consulting research organizations. A company of our size can afford its own central organization because there is always enough to do to keep it continuously busy.

ACCOUNTING PRACTICE

There is a tendency for a large centralized organization to impose an elaborate program of paper work upon its individual operations, particularly accounting. We have found that it is possible to overcontrol accounting-wise to the point where the control mechanism contributes to inefficiency.

Now each of our plants is provided with the staff and tools necessary to give it only such information as is needed for adequate control. The central accounting department takes care of correlation, standardization, and general corporate information.

BENEFITS FROM SMALL-PLANT OPERATION

There is no end to a discussion of our experience in manufacturing in small plants. Obviously, I have been able to hit only a few high spots and these only briefly.

In preparing this review, the thing that struck me most forcibly was that there is nothing we do in our small plants, in spite of the fact that over-all we are a large company, that independently operated small plants cannot do. True, there are services that our headquarters organization performs for these small plants, but don't forget that they cost money and are charged back in the prorates. Similar services are available through consulting firms to small companies, the only difference being that small companies do not always like to pay the cost, whereas our small plants have no choice.

Most large companies were once small but, in the process of becoming large, the management became absorbed, more and more, in major corporate matters to the point where intimate contact with the day-to-day operations and with the personnel was lost. Our feeling is that operating in small plants with a high degree of local authority and responsibility helps us to maintain that intimacy without losing any of the benefits of a strong central organization.

Public policy demands that no one company become so dominant in any field as to be in a position to control that market. Accordingly, it will be found that, while big companies will grow, their individual market positions will taper off. In fact, that process is already under way. Small business, in other words, has a fine future in this country. Bear in mind, however, that the consuming public will demand just as good performance and just as low a price from the small as from the large producer and sometimes better. It is essential, therefore, that small plants be just as alert to modern management practices and just as ready to invest in modern methods and facilities for improving products and reducing cost.

The Industrial-Management Engineer and His Place in Society

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INTRODUCTION

IN spite of its extraordinary and growing importance, the field of industrial engineering and management is not clearly delineated. Under various titles a group of related subjects and disciplines are presented in different schools and universities. Here it is called "administrative engineering," there "management engineering," but generally it is known as "industrial engineering." There is no doubt that there is confusion and, because of the confusion, this tremendously important field and profession suffers greatly. And, what is even more important—society suffers, because the applications of the theory and practices which the profession teaches are an important requirement in the highly technical and tightly integrated society of today. The day of intuitional decision and catch-as-catch-can planning has past; nineteenth-century thinking cannot solve the problems of the twentieth century.

PRODUCTION ENGINEERING

The development of industrial engineering has been from the shop and production engineering. From that concept has developed the main stem of the curriculum in the academic world and the industrial engineering departments as widely organized in industry.

The production engineer was originally concerned with "materials:"

1 What had to be done to them.
2 What were the available methods of doing it.
3 What were the physical and economic characteristics of doing it.

If the broad picture of industry of all kinds, analytical and synthetic, primary and secondary, are considered as the field in which the production engineer may rightfully concern himself, then the question quite properly may be asked what differentiates his activities from the activities of any one of his brother engineers?

In the past, certain limitations have been generally admitted. They are as follows:

1 Production but not distribution.
2 Synthetic industries but not analytical.
3 Mass production but not custom manufacture.
4 Mechanical processing but not chemical, mining, or construction.
5 Redesign for production but not for strength or function.

Doubtless there are other classifications which could be made, but these are sufficient. It is apparent that these previous limitations are not basic or fundamental but merely convenient statements of a status quo which has evolved. The profession has since matured, and no longer can it be constrained within such artificial and unscientific boundaries. The methods and procedures developed in production engineering have been taken over and applied in other fields, and the attempt made to adopt the practice but to exclude the practitioner.

In distribution: materials handling, effective storage and warehousing, work simplification, economic lot size are all important problems and all familiar to the production engineer. The methods of plant layout, flow analysis, process simplification, routing and scheduling, lot size are equally applicable in the analytical as in the synthetic field. While the great advantages from the application of the methods of the production engineer are obvious in the mass-production industries, yet, in the lot-production or intermittent industries, all the methods can be applied if the run is of sufficient duration. Even with custom industries, problems of standardization, machine loading, if properly solved, may mean the difference between success and failure.

In chemical industries there are important problems of process analysis, and in mining, as well as construction and chemical engineering, there are problems of materials handling. These are old and well recognized in industrial engineering. In design today, redesign, for the sensibility, capabilities, and limitations of the user and the operator, has been added to the field of interest of the production engineer.

While it is difficult to define uniquely the field of production engineering, on the other hand it is equally difficult to define uniquely the fields of any of the branches of engineering, if "uniquely" relates to the disciplines studied or the techniques applied. It is even more difficult if the attempt is made to have the definition both unique and exclusive. Rather than to try to define uniquely, it may be well to consider that the industrial engineer operates in an area and applies a certain way of thinking rather than a certain physical science.

It may be said that the production engineer:

1 Is interested in "the methods available for performing such operations as are required to change the form and properties of materials and articles with the view of adding utility thereby, at the best possible economic advantage consistent with the particular set of circumstances under consideration."

2 Is concerned with "the co-ordination of these methods in a total pattern, taking consideration not only of the physical characteristics of material and machines (processes) but, equally important, of the human resources and energies; physical, mental, and sociological."

3 Applies "an ordered method of procedure in varied fields and is primarily concerned with the method, its applications and development, rather than limited to a specific or circumscribed field of application."

4 Attempts to "so order the necessary activity that there will be the maximum gain at the minimum cost, both in the short and the long run."

It is these points of view, interests, and concerns which differentiate the production engineer from his brothers in other fields. When these statements, which definitely describe the operations of the production engineer, are studied closely they open up a surprising vista.

[1] Professor and Executive Officer; also Director of Research, Long Island Lighting Company, Long Island City, N. Y.

This, then, defines the field of the production engineer; however, it does not define adequately industrial engineering as differentiated from production engineering, nor is it even partially satisfactory in so far as the modern concept of industrial engineering which has evolved, under the revealing title of industrial engineering and management, is concerned.

THE SCIENTIST—THE ENGINEER—AND THE ADMINISTRATOR

It will now be useful to differentiate the engineer (not just the industrial engineer, nor any specific engineer, but more particularly the "engineering function") from other operators—the scientist, and the administrator. Broadly it may be said that the scientist, whether physical, natural, life or social, is primarily concerned with theory. On the other hand the administrator, whether business (private) or governmental (public), is primarily concerned with operation of existing institutions. While such a "broad" statement is true in the main, it does not mean that the scientist is only concerned with discovering new laws, synthesizing philosophies, advancing knowledge on a broad front, and never concerning himself with the solution of specific problems. As a matter of fact, Bridgman, who was certainly a scientist, as distinguished from an engineer, claimed that the usefulness of the knowledge sought was one way to judge whether it was scientific or not. But it is true that the scientist is concerned primarily with such things. The promulgation of a new theory, the setting forth of a reasonable postulate, the establishment of a valid hypothesis to explain the behavior of some observed phenomenon is considered far more important than the solution of a specific problem of application.

The administrator, on the other hand, necessarily is concerned with the solution of problems of immediacy and the preservation of the present situation—the status quo. His, primarily, is the task of manipulating the available resources, to seek some accepted goal. His activities provide the great flywheel of the economic and social system. Continuance is his prime responsibility; adjustment, compromise, and conciliation are his tools. He does look forward, but his forward looking is "time-bound." This is an important differentiation. The scientist, too, is cognizant of time, but time as a series of related sequential events, not time specifically as a date or as a discrete series in the mathematical sense.

The engineer occupies a mid-position between these two functions. He is concerned with solving problems but mainly with solving them in new and "better" ways. Just as the scientist is concerned with research, with the advance of knowledge, so, too, is the engineer. But there is a deal of difference. It is not accidental that the adjective "pure" is applied to the work of many scientists. They, as it has been said, are concerned primarily with the expansion of man's knowledge of the world he lives in from the pure love of knowing more and more about more and more things—that is man's path to the stars. The engineer, however, is purposive in his research, a pragmatist at heart. Perhaps it is true, as some have claimed, that the engineer is concerned with the solution of "little" problems. But a lot of little problems, solved sequentially, in the end may mean a new theory. His research is apt to be concerned with how to use this theory, what theories are available, and what must be developed to solve this kind of a problem. Generally, he is more interested in knowing how accurate a statement is than he is with making the statement more accurate. That does not mean that he is not interested in basic research, but he is apt not to become interested in basic research unless and until he finds that the knowledge available is not sufficient to solve a problem that he has before him or that he visualizes may soon become important. He is not concerned primarily with precision or accuracy per se; he is only concerned with enough precision; with enough accuracy; with the ability to predict within certain limits; the "enough" being dependent upon the purpose. In the derivation of an equation, he automatically drops "terms of higher order," and will invariably use a simple approximate equation in preference to a complicated accurate one, if he knows that a required answer only has to be within a given range of accuracy. So, as compared with the scientist of any kind, the engineer is concerned with "solving practical problems," problems of any kind; the theory is a necessary evil, his pleasure and satisfaction is in accomplishment of specific tasks and, by and large, he has no predilection as to the use of a particular method of solution. Operational usefulness is one of his important value judgments.

The comparison of the engineer with the administrator shows similar likenesses and similar differences. As the administrator is concerned with "keeping things running" so, too, is the engineer but with a difference. If something breaks down, the administrator and the engineer would both attempt to get it back in service to restore the status quo. The engineer, however, would immediately start to think about why it happened and would try to devise some method whereby that same thing would not happen again. The machine that the administrator restored to service might run better than the one the engineer restored. The engineer, on the other hand, would probably in an hour, a day, or a week later come up with a device of some kind which would improve the future operation.

While these descriptions, attempting to differentiate among the scientist, the engineer, and the administrator are useful, they do not tell the whole story, nor is the growing importance of industrial engineering and management made entirely clear. Before doing this, one further description or classification is necessary. The administrator is primarily dealing with human beings in life situations of immediacy. Many of these situations have to do with machines and processes which are the product of the engineer's applications of the work of the physical scientist. Other situations have to do with the relations between men and machines, men with other men, as individuals and as groups with other groups. Many of the basic theories here are the fields of the social scientist and, just as the engineer relates the work of the physical scientist to the needs of the administrator, so, too, in these fields, the engineer can supply the connecting link which will translate a theory into an application.

THE INDUSTRIAL-MANAGEMENT ENGINEER AND SCHOOLS OF BUSINESS ADMINISTRATION

The industrial-management engineer on the one hand identifies himself as an engineer, with all that that implies, and on the other hand performs in the field of industrial enterprise and other associations. Not unnaturally, confusion sometimes arises as to the relative fields of the engineering school and the school of business administration. The difference in these fields is not so much subject matter covered, but rather a method of attack caused by the different prerequisites brought by the two groups of students, different experiences of the instructors, and different basic ways of thinking. The instructor from the school of business has his roots in economics, the market place, distribution, and line activities of operating, usually trading, mercantile and service associations. The engineer has his roots in the physical sciences, the manufacturing plant, and is concerned with production. Many of the contributions of the engineer which have so superlatively demonstrated their usefulnesses, are being, quite naturally, grasped by the business administrator and used in the design of office procedure and other similar situations.

When it comes to top management, either the engineer or the business administrator may reach the top, although with

the increasing complexity and tempo of our society, the engineers are assuming an increasingly important place. In a recent study by Jackson Martindell it was pointed out that, in the top management of "well-managed" enterprises of all kinds, the men with engineering education formed the single largest distinguishable group. The major difference will be in the path by which the top was attained.

If a valid distinction may be made between organization and administration, both being considered a part of management, then the engineer is apt to be concerned with organization—the design of the structure; the business administrator with the administration—the operation. Both interest themselves in appraisal, evaluation, and basic decisions affecting policy and determining redesign of structure and procedure, and reconstruction of goals. Thinking in terms of the organization of an enterprise, the business administrator will be on the line, putting policies into effect by day-to-day contact with the public or with other members of the group. The engineer, except at the top level, will be making studies of existing practices, of situations, in solving problems—making designs, and in planning for future action.

As to academic specialties, there are some which are very distinct. Accounting, the theory of finance, banking, insurance, taxation, trade, advertising, sales promotion, and the like, are clearly matters in which the school of business has a rightful and proper interest. Similarly, manufacturing, product design, fabrication, machine applications, and materials selection, inspection and packaging, plant layout, materials handling, transportation facilities, both internal and external, are all matters which clearly belong to engineering.

There are, however, a number of fields in which no such clear-cut differentiation appears. Some of these problem areas are as follows:

1 Personnel and labor relations.
2 Economic applications and costs.
3 Statistical methods—analysis and control.
4 Organization, management, and administration.

In the field of personnel and labor relations, there appears to be a reasonably valid distinction between the application of personnel policies, as indicated by procedures, and labor negotiations. It is necessary that these be separated. This is indicated by the fact that they are separately organized in most operating companies. The former can be considered an engineering function, the latter belonging to the business administrator. However, neither of these two disciplines can set forth a valid claim to basic authority in this field. The theoretical courses belong in neither school. It is to be hoped that the social sciences will recognize their responsibility and will develop the basic fundamental courses which are so badly needed.

Both disciplines are concerned with economic applications and costs. In this field the business administrator is close to economic theory and, in effect, translates the theorems of classical economics into practice. The basis of most of his thinking is market-place transactions and business institutions. The engineer's consideration stems from the production plant, and his concern is with making decisions involving alternative choices in which the value judgments are based upon different costs, balanced against different performances and different probabilities of the occurrence of future events.

The engineer finds two major fields of application, the one which he is apt to call cost engineering, and the other managerial control. Cost engineering is concerned with the evaluation of alternatives, considerations of depreciation, service life, valuation, appraisal, and problems very closely related to, but not identical with, cost accounting. In some schools, however, industrial engineering claims and successfully demonstrates its authority in this field vis-à-vis schools of business. Studies to determine the "correct" method of "loading," the establishment of standard costs of all kinds, and problems of cost allocation in multiproduct industries and for multipurpose investment will concern him greatly.

In the field of managerial control, he will be concerned with methods of budgeting and the application of such modern methods as quality control to budgeting. His interest will also embrace such problems as the mechanization of accounting procedures and a lively interest in the field of controllership.

The use of statistical methodology is essential to almost every productive activity today. The basic backgrounds and interests of the students are entirely different. The engineer is concerned with sampling, quality control, and the use of statistical techniques to help devise laws, and to explain physical research (largely). The school of business, on the other hand, is concerned with index numbers, mass phenomena, business cycles, time series, and similar matters. The mathematical background that the engineer brings to statistics gives him an enormous advantage over his business-school confrere.

In the field of management—organization, and administration—there is real conflict. In every one of man's activities management problems arise and, while distinction can be made between "business management" and "production management," such a distinction will only provide a basis of operation without differentiation. If, however, reference is made to the prior statement as to the basic differentiation between the two disciplines, a more fundamental differentiation appears. Now the engineer would be concerned with research in the field leading to test applications of the findings of researchers, by business administrators perhaps. The engineer in attempting on the one hand to understand and synthesize the researches and findings of the social scientist, the cultural anthropologist, the psychologist, and the sociologist, and on the other hand attempting to mathematize the theories of the group dynamics and other schools, will explore the possibilities of models taken from the nuclear physicist and other engineers, especially the electrical engineer with his feedback and similar electronic concepts. From a historical point of view there can be no denial of the industrial engineer's interest and contribution in this field. The origination of the scientific-management movement was the engineer's contribution!

THE INDUSTRIAL-MANAGEMENT ENGINEER AND THE SOCIAL SCIENCES

Increasingly, it becomes obvious that the industrial-management engineer is destined to occupy a similar position to many of the social sciences that the other engineers occupy in relation to the physical sciences of chemistry and physics. While the relation to economics has, to some extent, been recognized, the relationship to the other social sciences is only now appearing. In some schools, an occasional course in psychology or applied sociology has been admitted grudgingly as an elective in the undergraduate curriculum or required at the graduate level, but in this modern world this requirement of knowledge of the social sciences must become recognized, by a solid core of basic subject matter. Again, it is to be stressed that the social scientists must assume a responsibility to develop the same kind of fundamental teachings in their fields that the physicist, the chemist, and the mathematician have already done in theirs.

In the field of personnel, the industrial psychologist, and the industrial engineer have rubbed shoulders for a number of years, and both have profited greatly thereby. Increasingly, the engineer is coming to depend upon the psychologist for his knowledge of the capabilities of human beings, and his incorporating

this knowledge into the design of his products and into his redesign, organization of processes, tasks, and jobs. The work place is in process of redesign, the place itself, the handtool, the machine tool, the bench, and the chair. Light, noise, vibration, color, and a host of other materials, which the industrial psychologist has been studying, are avidly grasped by the engineer and used—used successfully in his day-to-day solution of problems.

Today, the findings of the cultural anthropologist and the sociologist are being studied and already are being applied. As the researches proceed and theories develop—and it is believed that it must be a joint undertaking—the engineer will try them out and adapt them in his designs. The engineer is not a social scientist nor does he intend to become one, but he perforce is interested in what the social scientist is doing.

The social scientist is concerned with the laws of behavior of the individual as an individual and in groups. The engineer is interested in applying these laws in the solution of specific problems of individuals and of groups in the workplace. While the sociologist is concerned with the interaction within a group—group dynamics and tensions—and the psychologist is concerned with the potentialities and capabilities of the individual and how they are released, the engineer is similarly concerned with the behavior of groups as associations of groups and with their combined output and interrelations. An industrial association is a combination of diverse groups seeking a common goal. It is with the interaction of these groups with their internal as well as their external problems that the engineer is concerned. The internal structure and dynamics within the group is the primary concern of the social scientists; he wishes to discover the laws of behavior. The engineer is interested in applying these laws within groups in the solution of specific problems, but he is interested basically in attempting to apply these same laws to the related heterogenous groups forming an association.

In a previous section, the concept of industrial engineering as "production engineering" was developed. Now that the threefold relationship between science, engineering, and administration has been presented, it is possible to develop the modern concept of the industrial and management engineer.

THE HISTORICAL DEVELOPMENT

The birth of industrial engineering was in the work of Taylor at the turn of the century. Although there is no doubt that much that Taylor presented was not new in detail (Babbage, a century earlier, for example), yet he is rightfully considered the creator of the profession.

His work can be categorized under three headings:

(*a*) The application of a scientific approach, hence "scientific management."

(*b*) The skeptical mind—"there must be a better way of doing this."

(*c*) The concept of unit operations.

This concept of unit operations is of great importance for it is the starting point of several of the areas of industrial engineering and, indeed, many branches of engineering. Here is implied the idea that a man with tools (or a machine) applies certain skills to materials and produces something new. The thought is that by study it is possible to devise a better perhaps a standard way of doing it. Inherent are a host of ideas, the appearance of the material when it is needed, the design of the tool or the machine to be most effective, and the instruction of the worker. The material, the tool, the human effort were studied, a set of directions was issued, and the worker was trained. In effect, this was a job of co-ordination of a single task. A total task was to be broken down into a series of, perhaps, sequential tasks and each was to be studied to devise a best way of doing the whole.

From this fundamental analysis developed the field of time and motion study, of work simplification, and the like. Quite naturally the related fields of wage determination, of job analysis and specification were developed; here is the industrial engineer's natural interest in the field of personnel.

Important though Taylor's work was in that specific field, it was far more important as a reactor. From the work of his followers, so well expressed by Mrs. Wallace Clark,[2] evolved the idea of industrial democracy, the concept that the worker himself could and would contribute as much to increased production as top management.

The increase of productivity due to the use of the existing techniques in these fields quite naturally suggested that the theories developed in connection with unit operations could well be expanded to the organization of similar or diverse, parallel, sequential, and service unit operations which together form an industrial association.

So developed the field of production control; routing, scheduling and dispatching, of planning, preparing and control. This may be considered the combination, in the most effective arrangement, of several semihomogeneous operations to accomplish one over-all objective. This outward expansion of the concept of "unit operations" brought a re-examination of the unit operations themselves—in a sort of feedback. It soon became apparent that the best way of doing a series of operations together was not necessarily attained by combining the best way of doing each separately. That was a fundamental concept—a basic concept of great importance—the concept of "total" consideration—the best way of doing a group of things is not necessarily the sum of the best ways of doing each!

As his profession matured, so too did the industrial-management engineer. Today industrial engineering and management reject the mechanistic point of view. Members of the profession realized that they are dealing with nonhomogeneous entities; with materials, machines; and men, and that they must of necessity consider the totality; that is, all aspects of a very complex totality. The industrial engineer realizes that he himself is incompetent to deal individually with all the problems, and so he is learning the languages of the social scientist so that he can converse with them, can bring them in to assist in the solution of problems of mutual interest, and can evaluate their various contributions.

In some schools, industrial engineering has developed as a series of semirelated subjects concerned mainly with the systematization of various management functions; production engineering and control, personnel and labor-relations techniques, industrial economics, and controls, such as budgeting and the like. However, if real progress is to be made, we must hold fast to the concept of totality. With a machine, for example, it is possible to study each part separately, and, by progressing from each to the next, can "understand" the machine and not only predict what it will do, but also the stimulus it will react to. That is the mechanistic viewpoint. However, that viewpoint will not work when considering industries, industrial associations, or, indeed any units which embrace human beings. What occurs is the result not only of direct external and internal factors, but also of the general environment and the occasion.

The theory and practice of interchangeability, standardization, and production control made possible the mass-production industries so characteristic of American industrial life, and which became so widely recognized that the methods were

[2] "The Challenge of the American Know-How," by Mrs. Wallace Clark, *Harpers*, New York, N. Y., 1948.

translated in such widely diverse fields as office management and business administration on the one hand, and in the military where it appears as logistics and operational planning.

It may be said that industrial engineering and management are twin-rooted. Everyone is familiar with the contribution of Taylor, but the world is not so familiar with the work of Towne and Rautenstrauch who introduced the idea of the engineer as an economist—though a very practical one. For example, it was the industrial engineers who saw the need of an established cost accounting, and they are today still very vitally interested with the field.

Now the field of industrial engineering and management divided into two paths—on the one hand the practical, the design of industrial enterprise—on the other hand, the theoretical, the theory of organization and management.

TODAY AND TOMORROW

Just as the industrial engineer of yesterday designed (organized) the shop and its procedures, so today he is concerned with the design of the whole industrial enterprise, the determination of what to make, at what price, of the fixed and working-capital requirements, and of the whole structure of communication, co-ordination and control of an industrial association. From observation, analysis, and synthesis, he determines the relationship which should exist to produce the most effective association, just as in time and motion study he attempts to produce the most effective method of performing a unit operation.

Thus we maintain that it is possible to establish design factors for associations and one of our most important jobs is to extend knowledge in that field by research. We expect to establish a series of factors by which an association can be designed whose performance can be predicted with considerable accuracy; actually with as much accuracy as a machine for example. ("Accuracy" is here used in the relative sense.)

But beside observation and determination of certain design factors, quite naturally there also has developed what is beginning to be recognized as a philosophy of organization and administration. The combination of the two may be thought of as the field of management. From a study of this philosophy it is becoming increasingly apparent that the industrial engineer must concern himself with any and every factor which affects production. That is a broad vista, but one which does not frighten the engineer greatly. The engineer has forever been a synthesizer—what he himself does not know he hasn't the slightest hesitation in inviting an expert in to tell him.

In one particular at least, the industrial engineer differs greatly from his brother engineers. The problems with which most engineers have to deal have precise answers. Not so with the industrial engineer. He must deal with human beings and so, in many cases, his problems do not have single correct answers. Rather, they have several answers; in other words, it is always a question of compromise with an eye to the probable occurrence of events in the future. What is best under the existing circumstances and the present circumstances may not be best under different occasions and circumstances. That does not mean that the problem is unsolvable. Rather, it does mean that there must be greater flexibility, greater understanding.

In the collection, observation, analysis, and synthesis of data for the production of design factors, and in the attempt to infer "laws" of organization and management, the industrial engineer has been forced to master statistical techniques. Owing to his training, he is particularly fitted to work in this area. During the past decade there have been greater advances in mathematical statistics. New and more powerful methods of handling observations have been developed, and the engineer's training in mathematics and scientific methodology makes him the logical person to translate these theories into practical applications. Modern scientific method is especially valuable in providing criteria for reliability and validity in the application of the engineering techniques. Industrial-engineering research is directed toward finding and implementing these criteria.

Once more there is a regenerative cycle. The knowledge gained from the study of the philosophy and theory of organization and management, together with the techniques made available by scientific analysis and statistics, is causing a revaluation of the whole field from time and motion study up. Increasingly, objectivity is being substituted for subjectivity test, and experiment for opinion, and understanding for hypothesis and intuitive belief.

However, it must be recognized that individual industrial units do not exist in an economic vacuum. There are competitors; there is an industry. Furthermore, few industries or industrial units are independent. Far from it. Today nearly half of the industrial enterprises do not produce for public sale; rather they produce for other producers. One of the prices that is paid for the high productivity of America is increasing complexity and interdependence. Increasingly, it becomes apparent that the methods developed in industrial engineering must be applied not just to individual units or indeed to industries, but to our national plant and, in the end, inevitably to our world. So it is reasonable that the industrial engineer should extend his horizons; should attempt to discover the interrelationships which exist within industries and between industries, within economies and between economies. If society is to continue to advance, it must continue to produce. It must produce more and more for less and less.

If there is to be planning, it is the engineer's part to contribute what he and, especially he, can. Without a scientific basis and an engineering application, planning can only lead to chaos. If there must be planning it must be engineering planning—rational, controlled planning—the application of those knowledges and techniques which it has been demonstrated will work by experience and which are not mere unproved speculation and theory.

Control in the broad sense includes the whole gamut from observation, through evaluation, to the establishment of remedial action. It is believed that the problem of control need not be as all-pervading as sometimes thought. It may well be that by the establishment of certain institutions, remedial control may become almost automatic. Attention is invited to a recent book by Norbert Wiener.[3] This modern mathematical presentation is, in effect, what the industrial engineer has been teaching and preaching for some time. It is the industrial engineer's job to attempt to design such remedial controls for the economic system just as the engineer, in general, has successfully designed remedial controls for his physical mechanisms.

The organization of industrial society is changing rapidly. During the early part of the century the typical executive was a lawyer, a banker, or an accountant, or, for that matter, in many cases, a "self-made man." Gradually the self-made man, the originator, passed out of the picture and his place was taken by the salesman or the consolidator. Now, increasingly, as industry becomes consolidated, as the costs of operation and persistence of associations become increasingly important, and as new technologies develop, the engineer is rising to a position of greater responsibility—on the one hand, as an engineer-scientist; and on the other hand, as an engineer-manager. As complexity and interdependence increase, the need for a co-

(Continued on page 411)

[3] "Cybernetics," by Norbert Wiener, John Wiley & Sons, Inc., New York, N. Y., 1948.

Present Status of

AIR-POLLUTION RESEARCH

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INTRODUCTION

METHODS for reducing air pollution have been studied for many years. Only within the past five years have these studies been intensified by public interest on a national scale. Barkley (1)[1] has covered the development of air-pollution ordinances very thoroughly. In following this historical development, the parallel growth of scientific knowledge is apparent.

During the past two years, many valuable symposiums have been held and bibliographies compiled on contaminants in the air and how to remove them (2–17). It is obvious that we have gathered a tremendous amount of information about the control of air pollution, but many gaps in our knowledge still remain. More economical methods of separating contaminants from the air must be developed. Medical research on the allowable limits for single and mixed-contaminant systems is especially needed.

The ASME Air Pollution Committee requested that a survey be made of air-pollution research. This is to include sources of published work, research in progress, and proposed future work. In obtaining this information, letters were sent to many of the workers in this field. Much of the information was obtained from these replies and from published papers. The Society is indebted to all who contributed so generously of their time and work.

WHAT IS AIR POLLUTION?

Just what do we mean by air pollution? Clearly, the term refers to foreign matter in the air. But how much foreign matter and what kinds of it must the air carry before we say that the air is "polluted?" A few decades ago, heavily contaminated air was often regarded as merely an inconvenience—part of the price we must pay for the benefits of the machine age. In those days, nothing short of a dense cloud of noxious fumes would have been described as "air pollution." At the other extreme, it might be said that any foreign matter in air is a pollutant, whether it is harmful or not. On this basis, even the refreshing air of a primeval forest is polluted, for it contains pollen, wind-borne dust, and gases from decaying vegetation.

For our purposes, a middle-of-the-road definition is more useful than either of these extremes. The present trend, which will be followed in this paper, is to define air pollution on the basis of its effects. There are, broadly, three major effects. One is injury to property, including crops and other vegetation; another is injury to health; and the last is the nuisance factor, involving human comfort and convenience.

Using this idea, we may define air pollution simply as any concentration of contaminants in the air which is injurious to property, to health, or to comfort. This definition puts the emphasis where it belongs—on results, not on arbitrarily chosen concentrations. It is a practical working definition.

Furthermore, this definition allows room for the effects of weather and topography. A stack-top concentration that would create real problems in Charleston or Los Angeles might be harmless on the flat windswept Great Plains. This is why the ability of the air in any area to disperse contaminant is so important a part of air-pollution studies.

PROBLEMS OF AN INDIVIDUAL PLANT

In discussing air pollution, one state official has said that most plants would be glad to install equipment to correct this condition if it were effective and practical. An industrialist has stated that the greatest drawback to more rapid progress in air-pollution control is the high cost of collecting equipment. With all the knowledge available, one would think that the control of contaminants would be simple. A city official has indicated that little of all this knowledge is practically usable in reducing the nuisance at a specific plant. To those who have studied these problems, it is evident that each plant presents an individual research problem. The method for reducing contaminants must be tailored to fit this individual situation.

What, then, are the factors that affect the control of air contaminants at a plant? The first information required is a knowledge of the physical and chemical nature of the contaminant, especially the particle size distribution. What concentrations of contaminants are found, what are the properties and compositions of the gases, and from what points do they leave the plant? Another important factor is the topography of the surrounding country and locations of population centers and farms. Of equal importance is the meteorological conditions under which contaminants are found to be objectionable. The potential market for the material separated is important. With this information available, it is possible to determine the equipment which will reduce the contaminants with the lowest cost. It is evident that this must be a plant-by-plant analysis to obtain the most economical control of these contaminants.

The same factors must be studied for a community or metropolitan area as for a single plant. Here the problem is made more complex by the many sources of contaminants and by the fact that the air is three-dimensional. Many of the newer techniques are directed at solving this type of problem. Even in a community survey it is necessary, after studying the overall conditions, to work out the details of reducing air contaminants, plant by plant.

PARTICLE SIZE DISTRIBUTION

There are three general divisions of air-borne contaminants according to their particle diameter. The larger particles, above 10 microns (1 micron = 1/25,400 in.), have a strong tendency to settle to the ground. Smaller particles, below 1

[1] Numbers in parentheses refer to Bibliography at end of paper.

Contributed by the Fuels and Power Divisions and the Air-Pollution Steering Committee, and presented at the Annual Meeting, New York, N. Y., November 26–December 1, 1950, of The American Society of Mechanical Engineers.

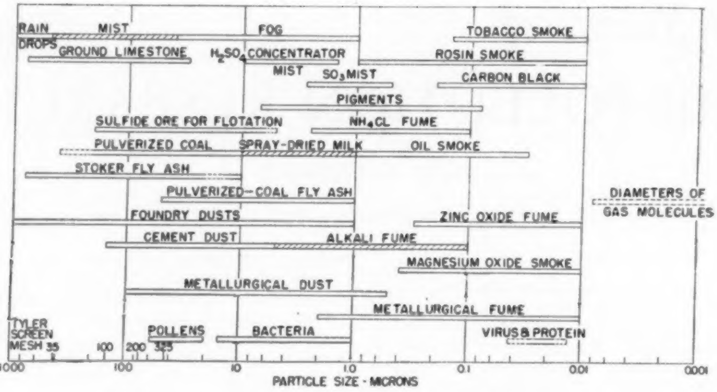

FIG. 1 PARTICLE SIZE RANGES FOR AEROSOLS, DUSTS, AND FUMES

micron, behave like aerosols and have little tendency to settle. Gases, such as SO_2, diffuse in all directions. The particle sizes of some common contaminants are shown in Fig. 1.

In measuring dirt fall, it is customary to expose an open jar for 30 days in a location which is representative of a given area. A considerable amount of work has been done in England on this subject (18, 19). Similar determinations have been made in many metropolitan areas of this country. It is agreed that there are many factors responsible for variations in this method of testing. Probably the most important of these is the selection of a truly representative location for the test jar. Also, the variation in weather conditions must be taken into consideration. Even though it is agreed that this is a rough test and that results must be averaged over several years to be significant, it is the only test that gives us a measure of the total dirt fall in a given area.

A new device has been developed at Battelle to increase the information secured by this test. It determines the amounts of dirt fall while the wind is blowing in various directions. Such a directional dirt-fall collector, placed in a heavily industrialized area, is expected to be useful in locating the direction from which large quantities of dirt come. Since this device is new, we cannot yet be sure just how useful it will be.

Several methods have been used for spot-checking specific areas. This has frequently been done by exposing "sticky paper," (20) and visually observing the dirt fall. A newer development (21) is to expose aluminum foil with a given area coated with vaseline. This foil may be weighed before and after exposure, obtaining a quantitative measure of dirt fall. These methods cannot be used when it is raining. Regardless of the equipment used, the only way to determine the total dirt fall is to measure it over an extended time—say 30 days or more, so as to take varying conditions into account.

AEROSOLS

Most of the work in sampling air-borne contaminants has been directed toward the determination of the amount and properties of aerosols present. These methods have been cataloged by Silverman (22). With a knowledge of the particle size of the contaminant, the proper sampling method may be selected. Then the concentration and chemical properties of the contaminant may be determined.

Among the newer developments (23) has been an adaptation of the Venturi scrubber for collecting small amounts of air-borne contaminants from large volumes of air. From these methods for sampling and determining the properties of aerosols, one may be selected which will be suitable for nearly any of the contaminants encountered in industry.

Neuberger (24) has shown the importance of condensation nuclei in the formation and persistence of smogs. Equipment designed by Vonnegut (25) is available which will determine continuously the number of such nuclei present in the air.

The methods just described are primarily for the short-time sampling of aerosols. The Owens automatic aerosols filter (26) and its modification used by Davidson (27) are suitable for measuring automatically the amount of "dark" aerosol constituents in the air at regular intervals. Equipment for continuously measuring both "light" and "dark" aerosol concentrations in the air is in the design stage. If there is a demand for such equipment, it could be developed rapidly. Using this continuous aerosol collector, it will be possible to obtain the variation of the total aerosols present throughout the day and night. It may also be possible to differentiate between the dark-colored aerosols, which are tarry or carbonaceous particles, and light-colored aerosols, which represent fly ash and similar materials. With the continuous collector, it may also be possible to correlate wind direction with aerosol concentration.

GASES

The gases most frequently encountered in air-pollution work are the sulphur-bearing gases. Equipment is available for measuring the concentrations of these gases continuously (28, 29), or by means of portable equipment for fieldwork (30). When other gases are known to be present, they may be collected and analyzed by conventional chemical methods.

In certain cases it has been found that gaseous contaminants, other than SO_2 and fluorine, are present which can cause plant damage (31). Where these gases have not been identified, research must be carried on to determine their chemical nature, concentration, and source. Only then can research find a method to remove them from the plant effluent.

TOPOGRAPHY AND METEOROLOGY

In the dispersion of air-borne contaminants, topography plays a major role. Flat terrain, especially near the Great Lakes where strong winds are frequent, favors the rapid dispersal of aerosols and gases. Narrow deep valleys furnish pockets in which contaminants may collect to form relatively high concentrations. When the air at ground level is colder than the

air above it, a temperature inversion is formed. Under these conditions, the air is stable, and there is little tendency to disperse contaminants by mixing. These temperature inversions are much more dangerous over an industrial area when it is surrounded by hills. During certain seasons of the year, radiation fogs in these areas may build up to such an extent that sunlight is unable to disperse them. As Hebley has pointed out (32), the air, cooled by the radiation of the hillside to a clear sky, drains down into the valley and increases the intensity of the temperature inversion.

Most of the meteorological measurements above ground level have been made with instruments attached to fixed structures. During the war the Armed Services developed techniques using Kytoons (kite-balloons, Fig. 2), for measuring temperature and humidity at altitudes up to 2000 ft. Work at Oak Ridge (33) has refined this technique to record continuously the temperature up to 3000 ft. These measurements are made by suspending a wiresonde or thermistor from Kytoons, Fig. 3, and bringing the electrical impulse to ground level to be measured or recorded.

Measuring the wind velocity at chimney-top level and higher is important in the dispersion of gaseous contaminants. Until recently, these measurements could be made only from fixed structures or by using free balloons at altitudes of 800 ft and higher. A new technique (34), using Kytoons, permits the measurements of wind velocity and direction at various altitudes up to 500 ft and higher. A low-velocity wind tunnel has been used (35) to investigate the part that building design, stack height, gas velocity, and wind velocity play in controlling the path of smoke from the stack.

LOW-ALTITUDE SAMPLING OF CONTAMINANTS

Most sampling of air for contaminants has been at ground level. The use of Kytoons as a skyhook has been adapted to the sampling of gases and particulate matter (34) at low altitudes. Samples of gas are drawn through polyethylene tubing to ground level for analysis. Instruments for sampling particulate matter, such as an electrostatic precipitator or impinger, are raised to the desired altitude for collecting samples of contaminants. Equipment for this work is shown in Figs. 4, 5, and 6. Another application has been the exploring of air currents in rugged terrain under various meteorological conditions. In this work, a smoke grenade, supported by Kytoons, is fired at the desired altitude. The path of the smoke is followed across the sky, both visually and photographically, as shown in Fig. 7.

With these new techniques, it is possible to determine contaminant concentrations at various altitudes up to 500 ft and higher on the windward and leeward side of the plant. In highly industrialized areas, these methods provide the tools for securing a three-dimensional picture of air-contaminant concentrations.

FIG. 3 WIRESONDE FOR MEASURING TEMPERATURE, HUMIDITY, OR WIND VELOCITY, SUPPORTED BY A KYTOON

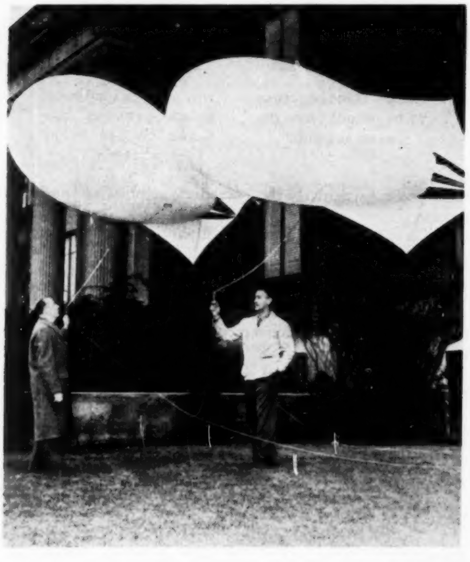

FIG. 2 KYTOONS USED AS SKYHOOKS FOR ELEVATING INSTRUMENTS TO VARIOUS ALTITUDES

METHODS FOR REMOVAL OF CONTAMINANTS

A number of methods are in common use for reducing air pollution. These have been fully described (36, 37) in various publications and symposiums. To mention only a few, production of smoke may be reduced by proper furnace design and the use of overfire jets. Fly ash is frequently collected by mechanical and electrostatic collectors. Industrial dusts may be collected by these same methods and also by baghouses and various types of scrubbers. Odors are sometimes treated chemically, or they may be removed by heat and incineration (45, 46). High chimneys, to obtain a maximum dispersion of gaseous contaminants such as SO_2, have been found very economical in some cases (38, 39). This list is not intended to be complete, but only to give an idea of typical methods which are used. The particle size of these dusts and the ranges over which collecting equipment is reported to be effective are shown in Fig. 8.

The latest improvements in collecting equipment have been in the newly designed mechanical separators, both wet and dry, and the Venturi scrubber (40, 41). In the Venturi scrubber, the water droplets are broken into a very fine mist. This mist is formed by the high velocity of the effluent gas, passing through the Venturi portion of the collector. These very small droplets wet and absorb very small particles by the Brownian movement in the air. Considerable work has been published on sonic agglomeration of contaminants in effluent gases (42, 43). It has been found that some particles have been found which do not stick together after some agglomeration. This method is not applicable to these materials. Different materials must be tested to determine their agglomerating characteristics.

Experimental work is continuing, and the field of usefulness of this method is being broadened. New designs and applications of the electrostatic precipitator are also in progress (44).

The greatest need of the present air-pollution-control program

FIG. 4 ELECTROSTATIC PRECIPITATORS WITH REELS OF WIRE AND CONTROL EQUIPMENT

FIG. 5 ELECTROSTATIC PRECIPITATOR HELD IN SAMPLING POSITION BY NYLON CORD TO KYTOONS

(Cables bring necessary voltages from ground level.)

is to find lower-cost methods for removing the smaller particles from effluent gases.

RESEARCH IN REDUCING AIR POLLUTION

Since air-pollution research touches and uses nearly all of the sciences, it is not possible to indicate more than a few of the directions that this research will take. From the practical standpoint, much effort is being expended in improving equipment based on present methods. This work will increase the efficiency and lower the installation and operating costs. Specific subjects for such research being carried on now include:

1 Means for improving electrostatic-precipitation efficiency of industrial dust whose electrical resistivity is high.

2 Reducing the erosion of electrodes by the dust carried in the gases.

3 Equalizing the distribution of the gas stream in the collecting equipment.

4 Elimination of clogging when collecting sticky dusts.

5 Obtaining longer life for bags in the bag house.

6 Developing a sonic generator with sufficient capacity for treating industrial effluents to determine by plant tests the fields in which agglomeration are practical.

7 Development of techniques for the collection and chemical identification of particles, particularly below 0.5 micron in size.

8 Engineering evaluation of methods of removing SO_2 from

FIG. 6 SAMPLING TUBE TO DRAW GAS FROM DESIRED ALTITUDE

FIG. 7 TRACE FROM SMOKE GRENADE ELEVATED TO 375 FT BY KYTOONS

stack gases, particularly the ammonium sulphite-sulphuric acid process.

9 Particle size distribution of sulphuric-acid mist from contact converters.

10 Effect of the electrostatic properties of aerosols on their removal in a Venturi scrubber.

11 The influence of building configuration and stack dimensions on smoke-trail characteristics in a low-velocity wind tunnel.

On the more fundamental side, research is being carried on in investigating the following:

1 Standardization of equipment and methods for determining particle size and concentration of aerosols.

2 Fundamental properties of aerosols, including size, shape, and electrical charge.

3 The development of new methods for removing suspended particles from gases.

4 The effect of sunlight on the reaction of contaminants in the air.

5 The oxidation of dilute SO_2 in sunlight and its contribution to low visibility.

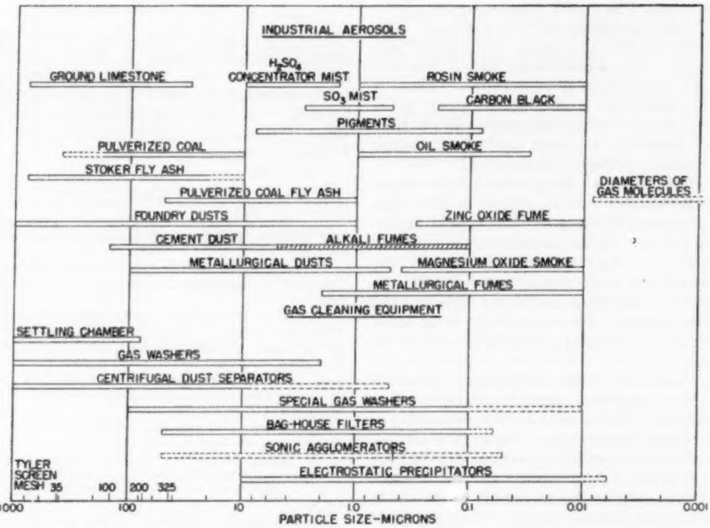

FIG. 8 PARTICLE SIZE OF INDUSTRIAL AEROSOLS, AND EQUIPMENT FOR CLEANING GASES

6 An extension of the theory of turbulent diffusion of gases and aerosols in the atmosphere.

7 The application of meteorological techniques to air-contaminant studies in highly industrialized areas.

A partial list of some of the subjects which need to be investigated is as follows:

1 A scientific study of the deposits of particulate matter from the atmosphere of industrial cities.

2 A scientific study of the aerosols and gases in the atmosphere of industrial cities.

3 A study of the low-altitude meteorology and contaminant-concentration gradient over industrial cities.

4 A determination of the concentration of condensation nuclei present and the part they play in the atmospheric conditions over industrial areas.

5 A long-range fundamental statistical study of the relation between the concentration of air contaminants and their effects on plants, animals (including human beings), and structures.

6 Improved methods and instruments for sampling and continuously recording the concentration of various contaminants.

7 The effect of topography, meteorology, stack design, and operating characteristics on the dispersion of contaminants.

8 Engineering studies with the publication of the data obtained on various types of equipment in actual operation for removing dust and fumes.

9 Development of new and more economical methods for treating gases to remove noxious contaminants at their source, such as SO_2, fluorine, and very fine industrial dusts and fumes.

10 Engineering studies of processes for utilizing gaseous and solid contaminants separated from effluent gases.

11 Studies in sonic agglomeration, which include the measurement and energy relationships of acoustical energy and a quantitative determination of the relationships between the physical properties of the contaminant, the configuration of the enclosure, and the rate of flocculation.

These lists of research, in progress and contemplated, show the tremendous interest in this subject. With all of the information available, much more is yet to be obtained. It is easy to see why several millions of dollars are spent annually for research in this field.

It should be emphasized again that merely obtaining the data from these research programs will not be sufficient. It will be necessary to study, plant by plant, the specific conditions which exist and apply the results of these research programs to each individual situation. This is the only way that the most economical system for air-pollution control will be obtained.

FUTURE OF AIR POLLUTION

With all of the interest and the research programs in progress, what does the future hold for air pollution? No crystal ball is required to see that close co-ordination of the research in these various fields is needed. A rapid exchange of experimental results will give a maximum of progress with a minimum of cost. The ASME has always been a leader in the power-plant and fuel-utilization fields. Other groups have periodically organized air-pollution symposiums. The Air Pollution and Smoke Prevention Association of America (APSPAA) has been reorganized to broaden its scope. In this organization, a Technical Conference has been arranged to bring together all those who are interested in the technical phases of this problem. It is hoped that this may offer a forum for the presentation of much of the original research work being done in this field.

The municipal and county programs in each industrial center actually form the backbone of air-pollution control (47). Each company within that area should work out its own program in co-operation with the local air-pollution-control engineer.

By such joint effort, founded on mutual respect, we can expect the greatest results with a minimum of effort and cost. This industrial program should make the widest use of the knowledge which is available. The technology for smoke control in both large and small installations is well known. There is little excuse for any installation having dollars going up its stacks in the form of smoke. Much information is available on fly-ash removal. With the equipment now on the market, most of the fly-ash nuisance problems can be solved.

There are many other industrial dusts, fumes, odors, and so forth, which must be handled. As mentioned earlier, these problems must be analyzed, individually, to find the most economical method for reducing the air contaminants to a reasonable level. If available information is not adequate for the problem, additional research work may be required. This research may be to find an economical method of collecting and disposing of the contaminant. Or it may even be to find a new method for producing the product, which does not form the noxious contaminant.

Finally, the future success of air-pollution control rests on the education of all of the segments of society regarding the facts involved in this problem. Each citizen has a responsibility in his own furnace and trash burner not to contaminate the air. The fireman in the factory, by improper practices, may be pouring soot and dirt on his wife's clean wash! And the executive in mahogany row must recognize the importance of a co-operative effort in keeping the community clean. Publicity of the company's expenditures and a co-operative effort may appreciably increase the morale and output of a plant.

But who pays for cleaner air? It has been demonstrated many times that it is the public who is going to pay for the cleaner air that it breathes. Not that it is not willing to pay the price, but it should know that it is going to have to pay the cost in the final analysis. Much of this cost will be recovered by lower crop and property damage and better living conditions.

Progress in this work will be slow. The public cannot expect the air pollution of any community to be eliminated in a year—probably not even in 10 years. It will take patience, hard work, and the application of our increasing knowledge to make the improvement. It will take constant vigilance to maintain the cleanliness of the air. Even so, it is believed that the benefits to be derived from clean air justify the effort. It is up to each one of us to do his part.

SUMMARY

Many symposiums and bibliographies have been published on air pollution in the past several years. Technology is available to practically eliminate smoke and handle most of the fly-ash problems. Each plant industrial problem must be analyzed individually to secure the most economical solution to the problem. A great deal of information is available as a guide in sampling and analyzing air contaminants. The newer techniques make possible the determination of the concentration of air contaminants at various altitudes as well as at ground level. Meteorological observations at chimney-top level and higher are important. A new continuous aerosol analyzer and a dirt-fall collector indicate the wind direction from which the largest amount of air contaminants is coming. A low-velocity wind tunnel, condensation-nuclei recorder, miniature Venturi scrubber, and other equipment are being perfected to furnish specific information.

Close co-ordination between the air-pollution-control officers, industry, and research organizations is required for the most rapid progress. Education of all parties concerned will be necessary. With a co-operative effort, progress will be made, and the air will gradually improve as additional equipment is perfected and used.

ACKNOWLEDGMENT

This paper could not have been written except for the co-operation of many persons. In addition to the communications referred to in the text, numerous other letters with interesting information were received. The author wishes to acknowledge his debt to all those who generously assisted in this compilation. Appreciation is expressed also to Battelle Institute for its financial support in this work.

BIBLIOGRAPHY

1 "Review of Air-Pollution Prevention in the United States," by J. F. Barkley, MECHANICAL ENGINEERING, vol. 73, April, 1951, pp. 284–288.

2 "Symposium on Atmospheric Contamination and Purification," *Industrial and Engineering Chemistry*, vol. 41, November, 1949, pp. 2383–2486.

3 "First National Air Pollution Symposium," sponsored by Standard Research Institute; California Institute of Technology; University of California; University of Southern California, Los Angeles, Calif., November 10, 1949.

4 "Lectures," presented at The Inservice Training Course in Air Pollution, February 6–8, 1950, School of Public Health, University of Michigan, Ann Arbor, Mich.

5 "Industrial Waste Symposium," AIChE, *Chemical Engineering Progress*, vol. 46, August, 1950, p. 377.

6 "Symposium—Air Pollution Control," AICHE papers presented at Columbus, Ohio, December 6, 1950, meeting.

7 "Transactions of the Smoke Prevention Association of America," 1930–1950.

8 "United States Technical Conference on Air Pollution," Washington, D. C., May, 1950. Papers to be published by McGraw-Hill Book Company, Inc., New York, N. Y.

9 "Symposium on Air Pollution," Midwest Power Conference, Illinois Institute of Technology, Chicago, Ill., vol. 12, April, 1950, pp. 33–320.

10 "Symposium on Atmospheric Pollution," American Meteorological Society, St. Louis, Mo., January 3, 1950.

11 "Relating to Atmospheric Pollution," Bureau of Mines Publications, February 9, 1950.

12 "Symposium on Dust Collection and Control," ASME Process Industries Division, Pittsburgh, Pa., April, 1950.

13 "Biological Aspects of Air Pollution," U. S. Public Health Service, April, 1950.

14 "Air Pollution in Donora, Pa.," U. S. Public Health Bulletin No. 306, 1949.

15 "Smoke Abatement: Current Practices and Regulations," Report 48-2, American Municipal Association, Chicago, Ill., February, 1949.

16 "Second Interim Report," by Stanford Research Institute, Western Oil and Gas Association, Los Angeles, Calif., August, 1949.

17 "Industrial Hygiene Foundation," Mellon Institute, Pittsburgh, Pa., Transactions Bulletin No. 13, November, 1949.

18 "Atmospheric Pollution in Leicester: A Scientific Survey," Air Pollution Research, Technical Paper No. 1, London, England, 1945.

19 "The Investigation of Atmospheric Pollution," Observations to March 31, 1944, His Majesty's Stationery Office, London, England, 1949.

20 "Private Communication," by H. C. Ballman, City Smoke Engineer, Columbus, Ohio.

21 "Private Communication," by W. F. Fredericks, Department of Public Health, Detroit, Mich.

22 Leslie Silverman, Proceedings of the First National Air Symposium, 1949, p. 55.

23 P. L. Magill, Proceedings of the First National Air Symposium, 1949, p. 61.

24 "Condensation Nuclei: Their Significance in Atmospheric Pollution," by Hans Neuberger, MECHANICAL ENGINEERING, vol. 70, 1948, pp. 221–225.

25 "The Condensation Nuclei Counter for Measurements of Air Pollution," by Bernard Vonnegut, presented before the American Meteorological Society, St. Louis, Mo., January 4, 1950.

26 "Atmospheric Pollution in Leicester," Department of Science and Industrial Research, Technical Paper No. 1, His Majesty's Stationery Office, London, England, 1945, p. 16.

27 "Automatic Dust-Sampling and Analyzing Instrument for Atmospheric Pollution Surveys;" "A Study of Atmospheric Pollution," by W. F. Davidson and Warren Masters, *Monthly Weather Review*, vol. 69, September, 1941, p. 257; vol. 70, October, 1942, p. 225.

28 "Automatic Apparatus for Determination of Small Concentrations of Sulphur Dioxide in Air," by M. D. Thomas, S. O. Ivie, and

T. C. Fitt, *Industrial and Engineering Chemistry*, Analytical Edition, vol. 18, 1946, p. 383.

29 "The Continuous Measurement of SO_2 and H_2S Concentrations by Automatic Titration," by H. W. Washburn, Proceedings of the First National Air Symposium, 1949, p. 69.

30 "Private Communication," by M. D. Thomas, American Smelting and Refining Company, Salt Lake City, Utah.

31 John T. Middleton, J. B. Kendrick, and H. W. Schwalen, *Plant Disease Reporter*, U. S. Department of Agriculture, vol. 34, September 15, 1950, p. 245.

32 "Stability of the Atmosphere and Its Influence on Air Pollution," by H. F. Hebley, MECHANICAL ENGINEERING, vol. 70, 1948, pp. 407–413; and "Factors Rarely Considered in Smoke Abatement," by H. F. Hebley, MECHANICAL ENGINEERING, vol. 69, 1947, pp. 281–287.

33 "A Thermistor Temperature Recorder for Meteorological Survey," by C. A. Mossman, J. J. Lundholm, and P. E. Brown, ORNL Report 556, Oak Ridge National Laboratories, Oak Ridge, Tenn.

34 "Techniques for the Study of Air Pollution at Low Altitudes, by H. P Munger, AIChE Reprint, presented December 6, 1950.

35 "Private Communication," by G. H. Strom, director, Research Division, New York University, New York, N. Y.

36 "The Fume and Dust Problem in Industry," by H. V. Welch, Metals Trans., AIME, vol. 185, December, 1949, p. 934.

37 "Clean Air, The Engineer's Way," reprints from *Power*, July, 1947, to January, 1950 (14 articles in single reprint.)

38 "Dispersion of Gases From Tall Stack," by M. D. Thomas, G. R. Hill, and J. N. Abersold, *Industrial and Engineering Chemistry*, vol. 41, November, 1949, pp. 2409–2417.

39 "Dilution and Its Part in Effective Air Pollution Control," by G. R. Hill and M. D. Thomas, *Industrial Medicine and Surgery*, vol. 19, March, 1950, pp. 121–125.

40 "Deposition of Aerosol Particles From Moving Gas Streams," by H. F. Johnstone and M. H. Roberts, *Industrial and Engineering Chemistry*, vol. 41, November, 1949, p. 2417.

41 "Principles of Design, Application, and Performance of Dry Inertial and Motor Powered Dynamic Separation," by Joseph Dalla Valle, presented at the U. S. Technical Conference on Air Pollution, Washington, D. C., May, 1950. (McGraw-Hill Book Company, Inc., New York, N. Y.)

42 "Aggloneration of Smoke, Fog, or Dust Particles by Sonic Waves," by H. W. St. Clair, M. J. Spendlove, and E. V. Potter, *Industrial and Engineering Chemistry*, vol. 41, 1949, p. 2434; U. S. Bureau of Mines, R. I. 4218.

43 "Industrial Sonic Agglomeration and Collection Systems," by H. W. Danser and E. P. Neuman, *Industrial and Engineering Chemistry*, vol. 41, November, 1949, p. 2439.

44 Private communications.

45 "Odors, Physiology and Control," by C. P. McCord and W. N. Witheridge, McGraw-Hill Book Company, Inc., New York, N. Y., 1949.

46 "Catalytic Combustion of Hydrocarbon Vapors," by R. J. Ruff, presented at the U. S. Technical Conference on Air Pollution, Washington, D. C., May, 1950.

47 City Smoke Inspectors Conference, Proceedings of the Smoke Prevention Association of America, 1949, pp. 143–154.

The Industrial-Management Engineer and His Place in Society

(*Continued from page 404*)

ordinator and interpreter becomes more and more apparent. Perhaps the proper word is a catalyzer—someone to interpret semantics; someone who can bridge the gulf between the various sciences and techniques. It is submitted that the training of industrial engineering and management best fits a man for that post. The problems of our modern day are far too complicated to depend upon intuitive judgment for their solution. It is the engineer with his training in measurement and problem solving, with his basically objective and scientific viewpoint that increasingly we must depend upon. The future has no horizons. Whether we, as a people, persist as a people and a culture depends upon whether the engineer is permitted to apply engineering to the solution of the problems of our society, or whether we prefer to perish in the holocaust which will inevitably follow from the pursuit of intuition, subjectivity, and personal aggrandizement.

ACKNOWLEDGMENT

While this paper appears under the author's name, it is only in part the author's work. It represents the results of years of thinking by the group at Columbia known as the Department of Industrial Engineering and Management. We have, during that time, met weekly and tried to beat out a philosophy, indeed a theory of organization and management. This does not purport to be a statement of that philosophy, rather it represents a part of the framework within which that theory is evolving; nor does it, for that matter represent the sole contribution of the staff of industrial engineering. Other departments and disciplines—economics, sociology, psychology, and anthropology—have all contributed directly and indirectly, consciously and unwittingly. So too, has that group of practicing engineers who are the advisory committee for the department. The author shall not attempt to name all, or indeed, any who collectively and individually have contributed. For what it is worth, for better or for worse, he has attempted to set forth his understanding of the thinking of a group of people, dedicated to a common purpose. It is a very rewarding experience to be associated as executive officer of the department and administrator of this group—a group which is making an outstanding contribution to the development of a profession which forms one of the most important bases upon which is to be built our society, our way of life.

Synthetic Fur

WITH its sources of arctic fur dwindling because of the emergency, the Air Force has embarked on a scheme to come up with substitutes which can easily pass for the real thing in warmth, appearance, and cost.

Clothing experts in the Air Materiel Command's Engineering Division have duplicated wolf's fur and mouton with inexpensive, high-quality synthetic substitutes. Both products equal the natural furs in luster, softness, quality, and wearability, and they are produced at about one fifth normal cost.

Furs are used by the military in the arctic, where frequent —65 F temperatures can freeze a man's lungs. Parkas worn in cold-weather areas are usually trimmed with a three-inch strip of arctic timber, Siberian, or Canadian wolf fur. These fur strips act as a thermal barrier and preheat the air being breathed in.

The synthetic furs being developed by engineers in AMC's Aero Medical Laboratory consist of a nylon bristlelike material which is knitted into any desired form. Long fibers are woven into the nylon pile, giving a shaggy furlike effect. The pieces now being service-tested have been dyed a bluish-black color, although the synthetic mouton specimens range from a subdued brown to bright blues and oranges.

Rain presents no problem to the synthetic fur since the nylon material does not retain moisture. Particles of ice which form on the fur in subzero temperatures brush off easily and do not make the fur soggy or limp.

The new furs are said to be much more uniform than the natural product. They are easier to work with and can be cut in any desired shape or form. This is considered a great advantage over natural furs, which have to be sewn together to form a desired pattern. And, unlike the natural animal skins, the synthetic fur's weight and density can be controlled.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Engineering-College Enrollment

APPROXIMATELY 161,000 engineering students were enrolled in the fall of 1950 in the 142 schools accredited by the Engineers' Council for Professional Development, according to the annual report on enrollment in engineering colleges published in the February, 1950, issue of *The Journal of Engineering Education*. The report was prepared by Robert C. Story and Henry H. Armsby of the U. S. Office of Education.

Undergraduate students numbered 142,954, while 15,575 were studying for the master's degree, and 2795 students were studying for the doctor's degree.

The number of undergraduates enrolled in ECPD accredited schools decreased 20.9 per cent from the 198,000 students that were enrolled last year. And, according to recent estimates, there will be still further decreases in engineering-school enrollments, resulting in a severe shortage of future engineering manpower. (See "The Developing Critical Shortage of Engineers," by S. C. Hollister, Mechanical Engineering, February, 1951, pages 121 and 122.)

Two major factors contributed to the disproportionate decline in the number of engineering students this fall, according to the ASEE report: (1) The engineering schools, with predominantly male student bodies, suffered greater losses through graduation in 1949–1950 than did the colleges as a whole; (2) proportionately fewer freshmen enrolled in engineering colleges than in all higher institutions In engineering schools this fall, freshmen composed 18.2 per cent of all students as compared to an over-all 23 per cent. The consistently diminishing numbers of new students each year since the fall of 1946 portends a concomitant decline in the number of engineering graduates in the years immediately ahead.

Another disturbing element in the engineering-enrollment picture is the decline in the proportion of engineering students. Last fall the students enrolled in ECPD accredited institutions composed 8 per cent of all college students. This year the engineering students accounted for only 7 per cent of the total college enrollment. One fact clearly apparent from a comparison of engineering enrollment with all college enrollment, is that proportionately fewer students are choosing engineering as a career.

The 142 institutions accredited by the ECPD conferred during the year ending June 30, 1950, a total of 48,160 bachelor's degrees in engineering, 4865 master's and professional degrees, and 492 doctorates. These constitute 11.1 per cent of all bachelor's degrees conferred by U. S. colleges and universities, 8.4 per cent of all master's degrees, and 7.4 per cent of all doctorates. Last year these per cents were 11.4, 9.4, and 7.9, respectively.

The distribution of first degrees among the four principal engineering curricula was as follows: Mechanical engineering, 13,056; electrical engineering, 12,340; civil, 7312; and chemical, 4422.

Undergraduate enrollment in the four principal curriculums of ECPD accredited schools in the U. S. was as follows: Mechanical engineering, 32,156; electrical engineering, 29,001; civil engineering, 22,407; and chemical engineering, 13,559. Together these four curriculums enroll about 68 per cent of the total undergraduate engineering students. In the 1949 ASEE report they enrolled 71 per cent of the undergraduates.

The data contained in the report are based on a survey of engineering schools and colleges made in October, 1950, under the joint sponsorship of the U. S. Office of Education and the American Society for Engineering Education. In accordance with an agreement reached by the joint committee of the Office of Education and the ASEE, all institutions listed in the Office of Education Directory of Higher Education which reported that they conferred degrees in engineering during 1949–1950 were requested to supply data. Eight Canadian institutions were also included. Replies were received from all institutions accredited by the ECPD, from 48 other U. S. institutions, and from 7 in Canada.

As proposed by the joint ASEE and Office of Education Committee and approved by the ASEE general council, the tabulations in the report list individually only the ECPD accredited institutions (eligible for active institutional membership in the ASEE) but contain data for the other U. S. institutions as a group and for the Canadian institutions as a group. Detailed data for these two groups will be made available by the U. S. Office of Education.

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

Emergency Civil Works

THE emergency developments of the past year, as they relate to the Corps of Engineers' comprehensive program of waterways control and improvement and water resource conservation, were outlined by Brigadier-General C. H. Chorpening, assistant chief of engineers for Civil Works, Washington, D. C., before the annual meeting of the Associated General Contractors of America, Inc., in Boston, Mass.

The Corps of Engineers, in co-operation with the Bureau of the Budget, established that no new project would be initiated unless that project would make an important contribution to the defense effort. Projects under construction would be continued if they met specified needs. Also, certain projects now in progress would be continued where termination costs would impose substantial losses to the Government.

In the budget message which President Truman delivered Jan. 15, 1951, he said that following a careful review of power requirements for the defense program, seven new projects, all of which will provide substantial power benefits, are included in this budget. These new projects, together with the installation of additional power units in projects already under way and the related facilities required to transmit the power, are estimated to cost 1.5 billion dollars, and to provide 3.9 million kw of installed capacity. The projects are Hells Canyon, The Dalles and Ice Harbor in the Columbia Basin, Old Hickory on the Cumberland River, a steam plant in the Tennessee Valley, Gavins Point on the Missouri River, and the St. Lawrence seaway and power project.

General Chorpening pointed out that five of these requested projects are in the authorized civil-works program of the Corps of Engineers.

Old Hickory Lock and Dam is an important unit in the comprehensive program authorized for the Cumberland River Valley in Kentucky and Tennessee. Last May it was recognized that there would be a critical shortage of power in the southeastern region commencing in 1954. The Cumberland River has the only large remaining block of undeveloped hydroelectric power in the region. And the Old Hickory project, with an installation of 100,000 kw, is the most practical project from which to get a substantial block of power by 1954.

He added that since the emergency program was initiated, the power situation in this area will become even more critical. Besides the atomic-energy plant at Oak Ridge, the new Arnold Air Development Center at Tullahoma, Tenn., is also located there. Moreover, the area—strategically located on the inland water routes—undoubtedly will be further expanded with war industries. Consequently, the General declared, it is essential to initiate construction of the Old Hickory project immediately if power is to be produced in 1954.

The Gavins Point project—located across the state line between Nebraska and South Dakota—is one of the four major storage projects authorized to provide flood protection to the highly productive bottom lands and industrial and transportation centers on the Missouri River. It is a multiple-purpose project, designed primarily for flood control, and with a hydroelectric plant that will have an ultimate installed capacity of 100,000 kw. The plant will be interconnected by backbone intermission lines and loop grids with the Fort Peck, Garrison, Oahe, and Fort Randall system now under construction. The system would have an immediate load area comprising most of Montana, North and South Dakota, Nebraska, and parts of Iowa, Minnesota, and Wyoming. This region was the location of a number of vital World War II defense plants.

The need for adequate flood control, improved navigation channels, and greatly increased power production in the Pacific Northwest has been a national problem for a number of years. They are critical problems today. Two of the new projects requested in the 1952 budget are on the Columbia River system, in this region, he revealed.

The Dalles project is authorized for the main stem of the Columbia about 90 miles from the Portland, Ore., load area—which even now has a critical power deficit. The project will provide a 980,000-kw installed capacity. Of special significance is the fact that the estimated cost of firm power at the Dalles is about 2.4 mills per kwhr. This power will help materially in improving the reliability of the region's transmission system—particularly with regard to supplying power to the entire state of Oregon, and to southern Washington.

Of equal importance, the Dalles project will eliminate many of the handicaps now retarding navigation on the Columbia River. It will facilitate the movement of essential supplies. It will also reduce the pumping lift required to supply irrigation water to the arid agricultural lands adjacent to the pool.

The Ice Harbor Lock and Dam is the first of our multiple-purpose dams to provide slackwater navigation for 140 miles on the Snake River—a major tributary of the Columbia. It is strategically located to supply electric power to the critical Pasco defense area—now undergoing a power deficit—and to the Hanford Engineering Works of the Atomic Energy Commission. In furnishing this supply, it not only will meet a critical demand, but will also eliminate the expenditure of about $7 million for facilities to bring power into the Pasco area from Grand Coulee Dam. The initial power installation for Ice Harbor will be 195,000 kw capacity.

Of the 524 million dollars for construction in the proposed 1952 budget, 57 per cent is for application on multiple-purpose projects which include the production of hydroelectric power. Requests have also gone to Congress for funds which will permit initiation of planning on other projects of strategic importance in the defense program.

Several projects with high value to defense and national economic security could be—and perhaps may be—initiated in the near future, General Chorpening said. Notable among these projects is the proposed St. Lawrence Seaway and Power project, for which—President Truman points out—the defense program has created a new and special need.

In 1941 the Governments of the United States and Canada negotiated an agreement providing for the construction of dams and power works in the International Rapids section of the St. Lawrence River, and for completion of the Great Lakes-St. Lawrence deep waterway. Initiation of the project is dependent upon approval of the agreement by the Congress, as well as by the Parliament of Canada, together with the appropriation of necessary funds.

Briefly, the agreement contains two proposals. First, that both countries execute certain works to provide a deep waterway with a controlling channel depth of 27 ft and 30 ft over lock sills from the head of the Great Lakes to Montreal. Second, that a large block of hydroelectric power be developed in the International Rapids Section, to be evenly divided by the two countries.

Power development on the St. Lawrence is essential to an industrial area, where, as recently as 1948, brownouts were necessary in the Province of Ontario, and New York had to import an annual 2 billion kwhr from Canada. The proposed power installations would have a combined capacity of 2,200,000 hp and a combined installed generator capacity of 1,881,000 kw. That block of power, with an annual generation of 12.6 billion kwhr, is the largest remaining for development at any one point on the North American continent.

Funds for the initiation of this project—providing the necessary Congressional authorization is forthcoming—are included

in the President's Budget Message for the 1952 Fiscal Year. Surveys, plans, and specifications are in sufficient detail for the Corps of Engineers to initiate construction whenever so directed.

Another project of major importance to the national emergency, according to the General, is the Niagara Redevelopment—a project that will substantially assist, but far from relieve, the region's power deficit.

The recent Niagara water treaty between the United States and Canada was ratified Oct. 10, 1950. Its primary objective is, first, to safeguard the scenic beauty of the Niagara River and Falls, and second, to place the diversions of water from the river for power purposes on a permanent basis.

A previous treaty had provided that certain quantities of water could be withdrawn from the river for power generation by both countries; but it had not guaranteed any set amount of flow over the Falls. The new treaty, however, reserves certain minimum flows over the Falls during stated periods of time, and, in addition, provides for the construction—under supervision of the International Joint Commission—of remedial works to produce an unbroken crestline over the Falls. It also provides that all water not specifically reserved for scenic purposes shall be available for power production—equally divided between the two countries.

Actually, water made available for power—especially to the United States—is materially increased, General Chorpening stated. A well-planned redevelopment can take full advantage of modern engineering techniques, thus making possible the generation of far more power than was feasible at the time many of the existing plants were constructed.

Underwater soundings and surveys of shore-line topography are now being made, he said. The findings will be used in studies utilizing a large scale model now under construction at Waterways Experiment Station, in Vicksburg, Miss., and a smaller scale model being constructed by the Hydroelectric Power Commission of Ontario.

Gas-Oxygen Cutting Torch

A GASOLINE-OXYGEN cutting torch which is expected to bring an over-all saving of between 25 and 30 per cent to such operations as cutting, brazing, scarfing, and allied work over the acetylene-type torch has been developed by James A. Browning, Jun. ASME, an instructor at the Dartmouth College, Thayer School of Engineering, Hanover, N. H.

The torch itself is similar in operation and style to gas torches now on the market. In principle, however, it is quite different, Mr. Browning points out. Liquid gasoline under small positive pressure is introduced into the head of the torch. Here it enters an ejector where it forms a fine spray in the low-pressure oxygen stream. The mixture which then enters the torch tip consists of liquid gasoline, gasoline vapor, and oxygen. The tip acts as a heat exchanger. Heat picked up from the cutting flame passes back through the body of the tip where it is transferred to the combustible mixture. The liquid gasoline is changed to vapor, and a homogeneous mixture of vapor and oxygen issues from the orifices to be ignited. The mixture moves at high velocity through the tip. The gums and tars produced by the cracking action present (the heat exchange takes place at about 350 F) are carried out of the tip by this high-velocity stream. The result is that there is no "fouling-up" due to the accumulation of these heavy hydrocarbons. (Previous attempts in developing this type of torch failed due to the formation of these gums, according to Mr. Browning.)

In operation the low-pressure oxygen is first turned on. This

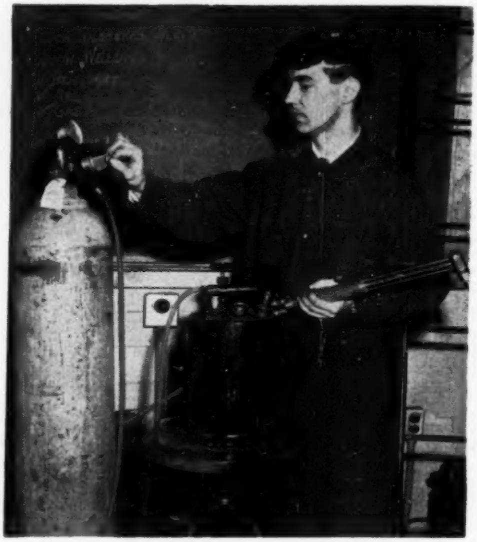

FIG. 1 JAMES A. BROWNING SHOWN WITH NEW GASOLINE-OXYGEN CUTTING TORCH

(The two-gallon gasoline tank in the center will do the same amount of work as 100 cu ft of acetylene under the same conditions, when combined with oxygen in the tank at left, according to Mr. Browning.)

oxygen acts as a carrier for the gasoline which is next turned on. The mixture is ignited by any conventional-type lighter. At first, the flame is rather yellow and cold. Within ten seconds the tip is sufficiently hot to cause proper fuel vaporization, and the flame during this period is progressively changed to a hot blue-white flame. Actual cutting is done in the same manner as a gas torch. The high-pressure system is conventional.

The chief advantage of the gasoline torch lies in the economy it promises in the cutting, brazing, and scarfing fields. (It will not fusion-weld due to an oxidizing action.) Fuel savings of over 80 per cent are reported. The cuts produced are extremely clean, and cutting speeds are higher than those of gaseous torches when compared on the same cutting oxygen consumption, Mr. Browning said. An over-all saving of 21.2 per cent was obtained in tests conducted cutting $^5/_8$-in. badly rusted plate. Different plate thicknesses, surface conditions, and the like, will necessarily change this figure somewhat.

It is fundamentally impossible to cause backflash through a liquid. This insures against an explosion in the fuel lines. The gasoline is stored under atmospheric pressure, making it less of a fire hazard than highly pressurized gaseous fuel tanks.

Complementary equipment consists of two hoses and gasoline tank. This tank is equipped with a fusible plug which will melt at 150 F. This avoids the building up of high pressures inside the tank due to outside heating. If for some reason the fuel line is severed, the fuel flow is immediately checked by means of a safety valve.

Other items such as portability, availability of fuel, and low flame velocity are also in favor of the gasoline torch.

Mr. Browning estimates that the new torch can be manufactured on a mass-production basis at about the same cost as the

acetylene torch. He hopes to have the new model in production within a year and to make it available to industries and the armed forces.

Materials Handling

MATERIALS-HANDLING equipment in the Railway Express service was described by C. G. Peterson, Railway Express Agency, Inc., New York, N. Y., during a 1950 ASME Annual Meeting, Materials Handling Division Technical Session. The Agency, Mr. Peterson pointed out, is 111 years old and is wholly owned by the railroads. It operates express service over all of the railroads of the country, and in addition, handles air express on all domestic air-mail carriers, including 17 trunk air lines and 11 feeder lines. Approximately 45,000 employees operate its 23,000 offices and 17,000 street motor vehicles. To a large extent these express employees run the 12,000 cars utilized in handling express on 33 exclusive express trains and more than 5500 passenger trains, with probably 1150 express cars being directly routed between large terminal cities. For rail express the total route-miles are almost 200,000. Air express is carried on some 1100 airplanes over routes totaling about 88,000 miles.

The scope of the services performed by Railway Express and the variety of shipments handled are far more diversified than those of most industries, public-service, or transportation concerns. The company has conducted an extensive campaign to handle its huge volume of express matter (about 15,000 tons occupying more than 100,000 cu yd are handled 12 times daily and all against a time deadline) with speed and economy. Mr. Peterson described such materials-handling equipment as platform trucks and tractors, conveyers, lift trucks and pallets, levers and rollers, containers, and miscellaneous equipment such as elevating-truck tail gates, powered platform sweepers, and jib cranes and chain hoists.

Nitro-Sphere

AN extremely high-strength pressure vessel has been fabricated by Research Welding and Engineering, South Gate, Calif., with the completion of a welded stainless-steel spherical storage chamber for use by the U. S. Air Force in rocket-propelled aircraft experiments. See frontispiece, page 374 of this issue.

The vessel is stressed to contain 200 gal of liquid nitrogen at 5500 psi and minus 340 F with a comfortable safety tolerance.

The vessel—nicknamed the "Nitro-Sphere"— is constructed from stainless-steel plate stock measuring 3 $^{11}/_{16}$ in. in thickness. The sphere measures 54 in. in diam and weighs approximately 7500 lb.

The relatively low weight is credited to the unique high-stress design. Alternate proposed designs, providing for a barrel-type structure, would have ranged in weight up to 15,000 lb.

Dy-Chek, the dye penetrant method, was used for inspection of all welds at frequent intervals in the assembly process.

An "exploded" cube layout was chosen inasmuch as it appeared to offer highest strength potentials.

Allegheny-Ludlum supplied six 3.687 × 38 × 38-in. stainless-steel plates, rolling them as a special lot from 347 ASTM-A240 Grade C stock at its Coatesville, Pa., mill.

The National Supply Company of Torrence, Calif., formed the plates to a 22.500-in. spherical radius, prepared a die and punch, and pressed the plates to shape after preheating them to 1700 F.

The plates were then laid out in the Research shops, and were trimmed on flame-cutting equipment. An interesting innovation in layout enabled the shaped plates to be both trimmed and beveled in the same operation.

A heavy-duty grinder was used to remove slag and residue from the trimming operation. To insure against contamination, the parts also were pickled.

The parts were then fitted and held temporarily in place with thin backing plates. All segments conformed symmetrically, and there was no joint misalignment.

First weld passes were made with Heliarc welding. These welds were then subjected to inspection by both gamma ray and Dy-Chek.

Following inspection of the first weld passes, the joints were filled by multiple-pass arc welding. General Electric Type 1347 $^{3}/_{16}$-in-diam coated electrode metallic arc rod was used. In all, nearly a ton of weld rod was used on the job. The combined gamma ray and Dy-Chek inspection processes were repeated several times as the welds were built up.

Final operation consisted of heat-treating to achieve a full annealed condition. The sphere was heated at 1950 F for 3$^{1}/_{2}$ hr and then subjected to both internal and external quenching through use of high-pressure jets.

It then was subjected to hydrostatic test at 10,000 psi in the Research Company's test chamber. Following this, the Nitro-Sphere was again inspected with both gamma ray and Dy-Chek.

Permanent-Mold Casting

A PERMANENT-MOLD 500-lb aluminum casting has been successfully produced by the John Hersch Bronze and Foundry Company, Cleveland, Ohio, it was announced by The Aluminum Association, New York, N. Y. The total production run on this unit is much smaller than that normally considered minimum for permanent-mold production. It was pointed out, however, that to produce it by this method costs only a fraction of what it costs to produce as a sand casting, and the permanent-mold casting also is said to be superior.

Originally the company began casting the part in sand. Because of the large size of the unit, this operation occupied four bays in the foundry. The use of a large sand slinger was

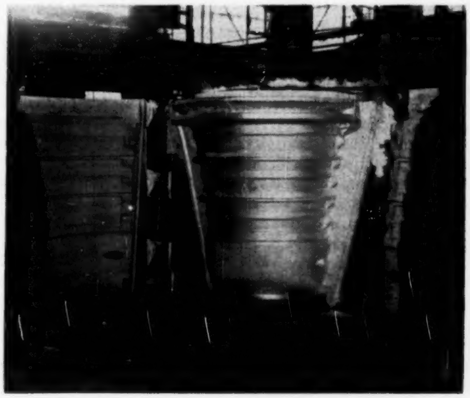

FIG. 2 COMPLETED PERMANENT-MOLD ALUMINUM CASTING READY TO BE EJECTED FROM MOLD

required in preparing the molds. Seven men could produce only four units a day.

To develop the required strength in the cast metal, the entire inner surface of the unit must be chilled. To accomplish this in sand casting required the use of a large number of iron "chills" placed close together in the mold. This resulted in a rough surface that was very difficult to machine.

To produce the unit as a permanent-mold casting, a mold of cast Meehanite weighing nearly ten tons was constructed. The mold is 65 in. high and has an average diameter of about 46 in. It is constructed of hinged sections which ride on rollers to facilitate opening and closing. Rows of gas burners surrounding the mold maintain it at uniform temperature for optimum pouring conditions.

The permanent-mold method is said to produce castings of higher strength than sand castings, and the smooth surfaces are easier to machine. Only one bay in the foundry is required for the permanent-mold operation, and four men can produce 12 units a day.

Aluminum Outlook

THE outlook for the aluminum industry for the years immediately ahead will be dominated by the trend of world politics, according to a study, "Aluminum—the Industry and the Four North American Producers," made by The First Boston Corporation. Already the present gravity of the world picture has dispelled the last doubts in the United States as to the necessity of a greatly expanded military budget, and other members of the United Nations are likewise becoming seriously concerned over the threat of World War III, the study states. As world preparedness increases, aluminum, in the dual role of a strategic war material and an essential civilian metal, will be in increasingly short supply, with the industry again entering a period of accelerated expansion of base facilities.

These pressures are already being experienced in the United States, where emergency programs are being initiated at a time when record peacetime production and imports fall short of meeting civilian demand. According to newspaper releases, the Government plans to enlarge its presently negligible aluminum stock pile at the rate of 300,000,000 lb a year for the next five years and estimates initial defense needs at another 350,000,000 lb annually.

To this end the first step was to divert some of the flow of aluminum from consumer channels to defense and stock-pile purposes. This was implemented by a National Production Authority directive restricting the use of aluminum for civilian purposes, based on the average for the first six months of 1950 when general business activity was nearly 10 per cent lower than at present. The allocation for January, 1951, was 80 per cent of that average, for February and March, 75 per cent—and deeper cuts may be imposed in subsequent months.

A second step, designed to meet over-all United States needs, is the plant construction and reactivation program, which will increase the nation's productive potential by the middle of 1952 by 1,050,000,000 lb a year, or about 68 per cent. Of this amount, 892,000,000 lb will represent new smelting capacity and 158,000,000 lb reactivation of idle productive facilities. Expediting contracts were drawn up at the same time in which General Services Administration, the government buying agency, agreed that:

1 It will guarantee sale of the entire capacity of the new facilities for a five-year period, beginning when the plants are substantially completed, at the market price, but retains the right of cancellation when half that capacity has been produced;

2 In the event of cancellation, it contracts to pay a termination fee equal to the then unamortized cost of the plants, which fee will be repayable to the Government over a ten-year period, based on a formula, if the facilities are subsequently operated;

3 It will certify the entire cost of the new plants for five-year amortization for tax purposes; and

4 It will certify the loans for government guarantee if the producer elects to finance construction with bank funds under a V-Loan agreement.

The heavy annual amortization charge over the five-year period precludes any important gain in earnings, but will result in large additions to working capital and cash funds.

It is reported that Kaiser Aluminum & Chemical Corporation's economic smelting capacity will be increased by 60 per cent, as against 44 per cent for Reynolds Metals, and 31 per cent for Aluminum Company of America. Furthermore, Kaiser will have its first reduction plant east of the Rockies, in proximity to major consuming markets.

Despite refusal of an offer to deliver 440,000,000 lb, or 200,000 metric tons of aluminum to the Government stock-pile by 1953, Aluminium Limited's Canadian subsidiary is going ahead with its own expansion and plant-reactivation program. It has been announced that the British Ministry of Supply is to take 1,410,944,000 lb of metal on firm orders during the three years 1951–1953. Present ingot capacity of approximately 903,900,000 lb will be increased by 44,100,000 lb of new capacity and 70,600,000 of reactivated plant, making a projected total of 1,018,600,000 lb, close to the peak level reached in World War II. On the basis of programs announced to date, the four major North American companies' approximate percentage of primary production capacity in the United States and in North America works out as shown in Table 1.

TABLE 1 PERCENTAGE BREAKDOWN OF PRESENT AND PROJECTED PRIMARY PRODUCTION CAPACITY OF NORTH AMERICAN PRODUCERS

	—United	States—	—North	America—
	Present	Potential Economic	Present	Potential Economic
Aluminium Limited	...	...	37%	28%
Aluminum Company of America	48%	40%	30	29
Kaiser Aluminum & Chemical Corporation	22	22	14	16
Reynolds Metals Company	30	28	19	20
Others	...	10	...	7
Total	100%	100%	100%	100%

Aeronautical Research

IN the 36th Annual Report of the National Advisory Committee for Aeronautics, Jerome C. Hunsaker, chairman, NACA, emphasized that the immediate need in aeronautical research lies in obtaining reliable information concerning aerodynamic forces in the transonic range, where the laws governing subsonic and supersonic speed interplay in a manner now imperfectly understood. Mr. Hunsaker is an Honorary Member of ASME and head of the Aeronautical Engineering Department of the Massachusetts Institute of Technology. In our high-speed research airplane program, the military services, the aircraft industry, and the Committee, participating as a development team, are making substantive progress, he said.

Research suggests that further investigations of certain basic problems should give opportunities to improve both airplanes and missiles operating in all speed ranges. These problems lie

in the fields of aerodynamic efficiency, stability, control, maneuverability, aeroelasticity, aerodynamic heating, and many others. For example, he pointed out, in the field of stability and control is the problem of matching the dynamics of the airplane with the capacities of human and automatic pilots, and of matching the aerodynamic characteristics of missiles with those of automatic control and guidance systems. Much precise information of this kind is required for new designs.

The speed range and load-carrying capacity of both military and civil aircraft are closely dependent upon the performance of of the propulsion system. The achievement of practical supersonic flight is made possible by the postwar revolution in aircraft power plants based on jet propulsion. The new power plants require great improvement to realize the aircraft performance now aerodynamically possible. Vigorous research is necessary to improve fuel economy, reduce specific weight and critical material content, improve ignition and combustion at high altitude and low temperatures, increase operating temperatures, and improve automatic controls and augmentation on all types of power plants.

Construction problems now being studied include aeroelasticity, aerodynamic and impact loads, structural efficiency, vibration and flutter, and new materials, Mr. Hunsaker revealed. Operational problems such as prevention of ice formation, fire prevention, effects of atmospheric turbulence, and means for emergency escape from high-speed aircraft, are under active investigation, as are problems peculiar to rotary-wing aircraft and to seaplanes.

Research to improve military aircraft is ultimately applied to civil aviation when proved to be thoroughly practical by experience, but there are differences in emphasis, because safety, comfort, and economy are relatively more important in civil airplanes. Special research is required on these subjects. Investigations are also in progress seeking to improve the safety and utility of light airplanes, such as might be privately owned and operated.

During World War II the Committee curtailed its programs of basic research in order to concentrate on applying available scientific knowledge to the immediate improvement of aircraft scheduled for war production, he said. This course was mandatory in view of the limited manpower and research facilities then available, but it was at the expense of the advancement of knowledge of the scientific problems of flight. Although some adjustment is required in the event of emergencies, Mr. Hunsaker warned that it must not occur again to the degree effected during World War II. To do so will undermine the research foundation upon which our future development program must be built. This is of even greater importance today than in prior years due to the decreased flow of fundamental research from European scientists and laboratories, and the probable extended prolongation of international tensions.

To make large supersonic wind tunnels available for the development problems of the aircraft industry, a Unitary Wind Tunnel plan was jointly drafted in 1946 by the military services and the Committee. This plan was designed to provide adequate postwar facilities, to eliminate duplication of effort, and to keep down over-all cost. In 1949 the plan was authorized by law, and in 1950 funds were appropriated for construction of some of the wind tunnels authorized. An important part of the plan, not yet implemented, is the University Wind Tunnel Program which is designed to insure a continuing supply of young men competent to participate in research programs utilizing facilities of the Committee, of industry, and of other laboratories.

In general, Mr. Hunsaker stated, difficult research problems are attacked from several sides. Wind-tunnel experiments, power-plant tests, mathematical-physical analyses, flight research, and sometimes unpredictable inventions may all be applied to a single problem. Such a problem may arise from current operational experience or it may stand as a bar to desired progress toward better performance. Often the real technical problem is so dimly perceived as to require exploratory research for its clear formulation before a definite program of investigation and experiment can be planned with any hope of useful results.

Rubber

ALTHOUGH synthetic rubber has replaced natural rubber in many fields, the rubber situation today is acute, Leora E. Straka, research librarian, Goodyear Tire and Rubber Company, Akron, Ohio, stated in a paper which she presented before a Rubber and Plastics Division Technical Session during the 1950 ASME Annual Meeting. The sources of 90 per cent of our natural-rubber supply are in jeopardy because of the political instability of Indonesia and the threats of communism in Malaya and Indo-China, she said. This is reflected in the price of natural rubber. In June, 1949, the price of GR-S was $18^1/_2$ cents per lb; in June, 1950, the price was the same. On Dec. 7, 1950, the price advanced to $24^1/_2$ cents per lb. In June, 1949, however, the price of natural rubber was 16 cents per lb; while one year later it was 35 cents per lb, and since then it has risen to as high as 90 cents per lb.

And all the while, she said, the uses of rubber, both natural and synthetic, are multiplying. The development of synthetic rubber during World War II advanced to such a stage that the natural variety can no longer compete with the synthetic product in many fields. Notable uses of rubber today are its use as a leather improver, in paints, and in road construction.

Latex and rubber emulsion paints are now available as paints of highly acceptable quality. Advantages are freedom from toxic solvents, good washability, short drying time, good application characteristics, and good shelf aging properties.

The durability, waterproofness, and abrasion resistance of leather can be increased by impregnation with a solution of natural or synthetic rubbers, and then vulcanizing with an accelerator of the dithiocarbamate type.

Rubberized coatings can now be applied to all the underneath parts of the car body, and the noise from flying stones can be effectively deadened.

Since rubber bearings have been widely used in marine service, tests have been developed for the measurement of their coefficient of friction and wear. By the suitable selection of elastomers and compounding ingredients, materials for bearings with lower coefficient of friction and longer life have been developed.

The use of rubber in road construction is continuing to stimulate further investigations of technologists and engineers. The results of tests to date indicate that rubber added to asphaltic paving material increases the life of the pavement, requires less maintenance, increases the elasticity of the pavement, reduces its susceptibility to temperature variations, makes the pavement less brittle at low temperatures, and materially increases the coefficient of friction of the surface area.

The most outstanding advancement in the field of frothed latex sponge within the last year, according to Miss Straka, is the production of a more uniform structure as a result of improvements in continuous frothing units. Other advances include smaller bubble size by controlled beater speed, along with improvements in processing methods and compounding techniques. The use of glass fibers serve as an extender and reinforcing agent, and cause articles to shrink less in the mold.

Within the past year "cold" rubber advanced from the batch process to the continuous polymerization process, she pointed out. Among the advantages of this process is the continuous blending of the ingredients which gives a more uniform latex and a product of higher and more uniform quality.

Among the new types of rubber announced during the year was vulcollan, a recently introduced highly elastic material that may find application in protective coatings. Neoprene Type W, another newly developed rubber, is more stable than other neoprene products and is characterized by greater resistance to compression set.

Depolymerized rubber, which has been under continuous development for a number of years, is now commercially available as DPR, a thick, flowable, all-rubber liquid. Depolymerized rubber compounds can be spread, troweled, or cast into molds, and vulcanized in hot air at atmospheric pressures.

The paper, as presented by Miss Straka, is published in full in the January, 1951, issue of *India Rubber World*.

Reinforced Plastics

REINFORCED plastic has become an important engineering material by doing jobs no other material can perform; by doing a better job than another material at the same cost; or by doing as good a job as some other material more economically, according to Leonard S. Meyer, chairman of the Reinforced Plastics Division of the Society of the Plastics Industry, Inc., and manager of the Plastics Division of Western Products, Inc., Newark, Ohio. In its many applications, he said, reinforced plastics have superseded, rather than substituted for, metal, wood, and other materials. Mr. Meyer spoke at an SPI meeting held recently in Chicago, Ill.

Born during World War II and applied successfully in many postwar civilian products, reinforced plastic is once again assuming military importance. However, it was noted, now as in the past, the uses for reinforced plastic are determined by its unique combination of properties, which no other engineering material offers—and not by its relative availability.

Because the components of this new material are not adequate to meet present demands, suppliers of the raw materials are discouraging new noncritical plastics applications. Thus, said Mr. Meyer, the manufacturer of a nonessential product, finding himself unable to obtain enough metal for production, is likely to be rebuffed when he tries switching to reinforced plastics.

The current misconception that the material is a "substitute" is also a source of worry to many manufacturers now using reinforced plastics in their products, notably to those who had redesigned around a change-over before the Korean outbreak solely because reinforced plastic was the best material for the job, he said.

The military crisis has actually inhibited a number of civilian developments for reinforced plastics because military programs have pre-empted a large share of the material supply. Present military applications of reinforced plastics, on an experimental or actual-use basis include: Radomes, aircraft ducting, crash helmets, ammunition boxes, carrying cases, tote boxes, small boats, life floats, plotting boards, bleach containers, shipboard pipe, battery cases, portable shelters, aircraft landing mats, etc.

First significant use of the material was for radomes during the early years of World War II. As a protective shield against the elements for delicate radar and electronic equipment, fibrous-glass-reinforced plastic was found to be ideal because it was nonmagnetic and nonconductive, strong, lightweight, and impervious to weathering—a combination of properties offered in required degrees by no other material, he said.

Reinforced plastics have been used in body armor strong enough to repel a 0.45-caliber projectile; in fishing rods that can't take a set and have properly varying degrees of flex and rigidity precisely engineered from handle to tip; in small boats and cabin cruisers that never need painting and are practically impervious to weathering; in washing-machine agitators, housings, and other parts nearly impossible or economically impractical to produce from metal; in electrical equipment laminates that are far tougher, more heat-resistant, smaller, and lighter than competitive materials; in housings for various consumer and industrial products that are tougher, lighter, and generally better than parts made from conventional material, yet cost less to produce.

As in past and present applications, Mr. Meyer pointed out, the future of reinforced plastics will be built on uses in which it does a better and more economical job.

Du Pont Story

HIGH LIGHTS from the history of E. I. du Pont de Nemours & Company have been recorded in a Technicolor motion picture entitled "The Du Pont Story." A 72-minute feature, the film goes back 149 years and shows how E. I. du Pont de Nemours, the young French immigrant, got his start. From there on, the administrations of du Pont's ten presidents formed convenient chapters for telling the story.

Among the milestones depicted is the regimé of Henry du Pont, who held longest presidential tenure, from 1850 to 1889. During this period came dynamite to share the explosives field with black powder, and the expansion of the company outside Wilmington, Del. This period was also marked by the invention of the cheaper blasting agent, "soda powder," by the founder's grandson, the first Lammot du Pont.

Other milestones include the launching of the company on its broad program of diversification in the early years of this century under the guidance of T. Coleman du Pont, the fifth president. Pierre S. du Pont guides it through World War I, and lays the basis for its impressive growth after the war.

Irenee du Pont establishes the present organization of the company, and shepherds the dyestuffs venture to ultimate success. Under the present Lammot du Pont, the company begins fundamental research, which brought nylon and other achievements and carried new products such as rayon, cellophane, and "Duco" lacquers to commercial success.

Walter S. Carpenter, Jr., ninth president, leads in carrying out the burden of the company's vast World War II effort. After initiating another great expansion following the war, he hands over the reins to Crawford H. Greenewalt early in 1948.

"The Du Pont Story" represents a major production effort. Ninety-one different sets were designed, built, and erected at the studio of Apex Film Corporation. Many were replicas of places in Wilmington, such as the first office building and the first home of E. I. du Pont de Nemours.

Electronic Currency Counter

AN automatic electronic machine for counting worn-out paper money has been designed and developed by H. M. Joseph and Carroll Stansbury of the National Bureau of Standards for the Department of the Treasury. The NBS electronic current counter counts 30,000 notes per hour. Twenty-five of these machines will be placed in service soon by the Treasury, replacing the present hand-count system and saving about $250,-000 annually.

Although new paper money has been machine-counted for

many years, mechanical handling of worn-out notes has until now been a perplexing problem. Money returned to the Treasury is in the form of packets of 100 notes cut longitudinally into half notes. About 8 tons of currency are turned in daily for redemption. The bulk of the returned money (about 5 million dollars' worth) consists of one dollar bills, constituting about 80 per cent of all the pieces of paper currency received for redemption. The notes are limp, wrinkled, and difficult to handle; occasionally single torn notes are taped together. The variable condition of returned money has required tedious counting by hand.

The electronic counter counts the packets of notes and automatically rejects those with more or less than 100. At the beginning of each counting cycle, a feeder mechanism pushes each packet endwise from an inclined trough into the opening between the spindle jaws. When a packet reaches this position, an electric limit switch is actuated, which causes the spindle jaws to clamp and rotate, rolling the packet around the spindle for counting. The jaws then release and the packet is cleared from the counting head by an additional revolution of the spindle. The released packet falls on a sheet-metal sorter vane which has been tilted to the correct or the reject position by an electromagnet responding to the count. The spindle jaws, together with an electromagnet which operates them, are carried in a rotating element of a turntable assembly mounted on top of the unit.

The counting is achieved by using an electronic sensing device consisting of a beam of light and a phototube system. As the notes are unfurled, interrupting the beam of light, the phototube senses the interruptions of the beam. Impulses from the phototube are fed to a binary counter which tallies the individual impulses. The sum of these impulses is used to actuate a sorting vane; if the count is 100, the sorting mechanism automatically sends the packet into an acceptance bin; if the count is more or less than 100, the packet is automatically ejected into a reject bin. Except for filling the trough with packets to be counted and removing those already counted, the machine operates unattended.

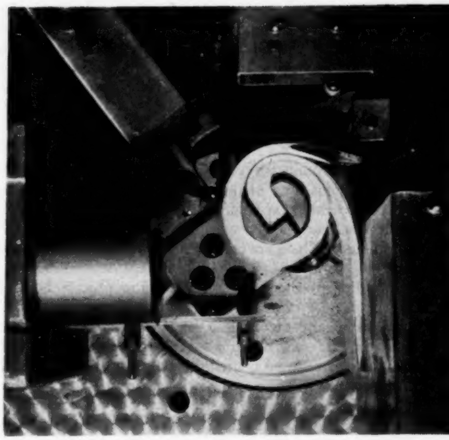

FIG. 4 COUNTING PERIOD OF NBS ELECTRONIC CURRENCY COUNTER

[A package of half notes has been firmly locked into the jaws of the spindle (*center*). As it rotates, the combined action of the friction band (curled around outer contour of packet) and of a jet of air (air hose, *center*) causes each note to break the light beam of a phototube (*left*).]

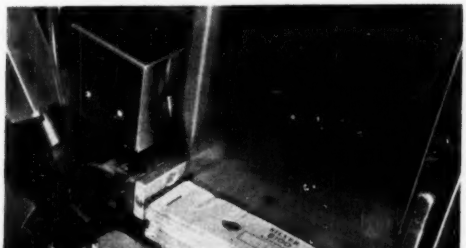

FIG. 3 FEEDING MECHANISM OF THE NBS ELECTRONIC CURRENCY COUNTER

[The pusher arm (*extreme right*) is beginning the motion which takes packaged "half notes" from the inclined feeder trough and pushes them into the open jaws of a spindle (*left of notes*).]

Each machine is a separate, completely self-contained unit, mounted on casters. For ease of maintenance the counter is composed of replaceable, completely interchangeable subassemblies.

In the event a packet of half notes tangles around the spindle, a limit switch stops the automatic feed until the machine is cleared by hand. Other limit switches stop the machine after it runs out of packets and interlock the motion of the turntable with that of the feeder mechanism.

Synthetic-Liquid-Fuels Industry

SECRETARY of the Interior Oscar L. Chapman announced recently that he is calling upon private enterprise, with government assistance under existing legislation, to establish promptly a synthetic-liquid-fuels industry based upon coal and oil shale. He made this disclosure in transmitting to the Congress a report on Bureau of Mines synthetic-liquid-fuels research during 1950.

The Secretary pledged the "full support" of the Department of the Interior to "competent organizations or groups of organizations" offering sound proposals for undertaking commercial oil-shale operations.

He added that the Department will also encourage the construction of one or two plants to produce synthetic liquid fuels by direct hydrogenation of coal. Regarding the other coal-to-oil process being studied by the Bureau of Mines—gas synthesis—he observed that further pilot plant and demonstration plant testing is necessary.

Citing increasing need for petroleum products in this country, the uncertain international situation threatening imports, and the heavy costs of discovering and developing new oil fields, Secretary Chapman said that prompt synthetic-fuel development is essential to safeguard our oil supply.

As the volumes of the report may be obtained separately, each of them includes a common introduction which sketches the broad aspects of the Government's synthetic-liquid-fuels research program and gives a technical summary of the entire report.

High lights of the report follow:

OIL FROM COAL

As a proving ground for American coals, equipment, and processing methods, a coal-hydrogenation demonstration plant has been operated experimentally near Louisiana, Mo., for a year and a half, and a gas-synthesis demonstration plant is nearly completed. These are the first plants of their kind in the United States.

The versatility of the coal-hydrogenation process is illustrated by the variety of chemicals that can be produced, if required, in important quantities. A single 30,000-bbl-a-day plant could increase the country's benzene production 20 per cent and at the same time contribute the following chemicals needed for defense: Toluene and xylene for aviation gasoline and explosives, tar acids for plastics, naphthylene for protective coatings, ammonia for fertilizer and explosives, together with sulphur and pyridene, which are in short supply. Producing these chemicals, the first coal-hydrogenation plants could make a noteworthy contribution to national defense in addition to preparing the way for large production of oil from coal.

Construction of the gas-synthesis demonstration plant at Louisiana, Mo., is about completed. Gasification equipment for this plant, which consists of a Koppers pulverized-coal gasifier and a Kerpely gas producer, was completed and in operation over a year ago. This has permitted a series of tests to iron out possible difficulties in gasification before the whole plant was finished. A total of 46 test runs, one lasting 11 days, were made in a Koppers pulverized-coal gasifier, after which a Kerpely gas producer was operated with two sizes of coke and with low-temperature char.

Research in the Bureau of Mines laboratories and pilot plants at Bruceton, Pa., covered three methods of obtaining oil from coal: (1) Synthesis of the products of gasification; (2) direct hydrogenation at pressures of 3000 to 10,000 psi; and (3) fluidized coal hydrogenation at relatively low pressures around 1000 psi.

At the Pittsburgh, Pa., laboratories the gasification of coal with oxygen and steam was studied in an experimental vortex-type unit equipped with a specially designed coal distributor.

Pilot-plant experiments in the gasification of pulverized coal at the Bureau of Mines, Morgantown, W. Va., station have helped make it less expensive to produce synthesis gas. This gas now accounts for 60 to 70 per cent of the cost of producing liquid fuels by the gas-synthesis process. In addition, coal is gasified to produce the hydrogen needed for the coal-hydrogenation process.

At Morgantown, in co-operation with West Virginia University, the Bureau has used a small-scale experimental plant for gasifying pulverized coal for several years. This is believed to have been the first pulverized-coal gasifier capable of continuous operation. (See "Gas-Synthesis Process" on page 421 of this issue.)

A larger pilot plant, gasifying coal with steam heated to 3500 F—an unprecedentedly high temperature for operations on this scale—and oxygen under atmospheric pressure, has converted more than 400 lb of coal per hr into high-quality synthesis gas.

The Alabama Power Company and the Bureau of Mines have jointly operated a field-scale experiment on gasifying coal underground at Gorgas, Ala., for 20 months. Gases produced by burning unmined coal in the bed under controlled conditions offer a possible low-cost fuel for generating electricity as well as materials for synthetic liquid fuels. (See "Underground Gasification" on page 421 of this issue.)

OIL FROM OIL SHALE

Successful operation at the Bureau of Mines shale-oil demonstration plant near Rifle, Colo., of a pilot plant extracting oil from shale by a new continuous process brought a domestic oil-shale industry nearer reality. Called the gas-combustion process because the necessary heat is obtained by burning a low Btu gas within the retort, this method requires no water or air cooling because the heat exchange between the gas and the shale takes place within the retort itself. As the nation's major oil-shale reserves are in semiarid country, it is considered a distinct advantage that no water is needed.

In addition, a recent estimate shows that both initial investment and the cost of the product would be lower with the gas-combustion process than with those using other types of retort, such as the gas flow, on which previous estimates were based.

At Rifle, it has been shown that gasoline meeting regular grade specifications and a good grade of Diesel fuel can be produced from shale oil by conventional petroleum-refining techniques. Tetraethyl lead blending equipment is being installed so that finished gasoline can be produced for road tests.

Laboratory experiments at the Bureau of Mines Petroleum and Oil-Shale Experiment Station at Laramie, Wyo., showed that retorting pulverized oil shale almost instantaneously at around 1500 F yields a highly aromatic crude oil. As it came from the retort, this oil was 15 per cent benzene by volume. Benzene is essential for making synthetic rubber, plastics, nylon, and insecticides.

The unleaded gasoline fraction of the oil produced in these laboratory experiments in radiant retorting contained 52.4 per cent benzene, 25.5 per cent toluene, and other higher aromatics.

A pilot plant in which this process of retorting oil shale can be tested on a somewhat larger scale is in design stages.

Retorting research at Laramie during the year was aimed at determining the effects of temperature and heating time upon the quantity and quality of the liquids and gases recovered. It was found that speedy heating at high temperature yields the most liquids.

Research on refining shale oil was carried on not only at Laramie, but also at Bruceton, Pa., during the year. The effectiveness of various techniques was studied. At Bruceton, about 40 bbl of coke distillate from crude shale oil were hydrogenated at pressures of less than 1500 psi. This treatment essentially eliminated sulphur and nitrogen, and yielded Diesel and jet fuels that met military specifications after minor blending with additives. Reforming would be necessary to produce satisfactory gasolines. Hydrogenation of crude shale oil under similar conditions was not entirely satisfactory.

LIQUID FUELS FROM AGRICULTURAL RESIDUES

At the site of the United States Department of Agriculture's Northern Regional Research Laboratory at Peoria, Ill., the Bureau of Agricultural and Industrial Chemistry during the first half of 1950 operated a semiworks plant producing alcohol and other liquid fuels from such agricultural residues as corncobs and the hulls of cottonseed, oats, and rice.

When the plant closed at the end of June, it had been operating continuously, processing 550 lb of corncobs per hr.

The plant was operated in close co-operation with the Northern Regional Research Laboratory, which is studying the conversion of the xylose in the pentosan hydrolyzates to fur-

fural, one of the higher alcohols, and the fermentation of the pentose and dextrose sugars to liquid fuels.

Basically, the hydrolysis under study consists of converting one fraction of agricultural residues—pentosans—into pentose sugars, and another fraction—cellulose—into dextrose. The pentose sugars may be fermented to the liquid fuels butanol, isopropynol, acetone, and ethanol, or they may be converted into furfural. Dextrose can be converted to the liquid fuel ethanol.

SECONDARY RECOVERY AND REFINING RESEARCH

Engineering field studies of secondary-recovery operations were made in the Mid-Continent, Texas, California, and Appalachian regions, and the results published so that other producers could learn what methods had proved most effective under various conditions. Although this research necessarily dealt with many individual problems, its ultimate goal was to increase the recovery from stripper fields by using carefully planned and engineered methods for stimulating the flow of oil.

Fundamental research added to knowledge of the forces that hold crude oil in the underground reservoir rocks. Problems of shooting oil and gas wells were attacked through research on explosives and their blast effects, and through a survey of the physical properties of oil-bearing rocks from representative fields. This survey was made possible because many interested oil and gas companies made drill cores available.

Work on the use of radioactive tracers to show the course of water injected into oil sands began during the period covered by the report. The effect of heat upon oil recovery was also explored.

REPORTS AVAILABLE

Because of the wide variety of interests covered, "Synthetic Liquid Fuels—Annual Report of the Secretary of the Interior for 1950," has been published by the Bureau of Mines in four separate Reports of Investigation as follows: R.I. 4770, Part I—Oil From Coal; R.I. 4771, Part II—Oil From Oil Shale; R.I. 4772, Part III—Liquid Fuels From Agricultural Residues; R.I. 4773, Part IV—Oil From Secondary Recovery and Refining.

A free copy of any of these publications may be obtained by a written request to the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa. The R. I. number and title of the publication desired should be indicated.

Gas-Synthesis Process

DEVELOPMENT of one of the first laboratory processes for the continuous production of synthesis gas from pulverized coal is described in a Bureau of Mines report released recently by the United States Department of the Interior. The process offers an easily controlled method for testing the gas-making qualities of various types of fuels.

Synthesis gas—a mixture of carbon monoxide and hydrogen—required for the manufacture of synthetic-liquid fuels is a product of coal gasification, which is the first basic step for the indirect Fischer-Tropsch process for producing such fuels.

Developed by the Bureau's Synthesis Gas Production Laboratories at Morgantown, W. Va., in co-operation with West Virginia University, the laboratory-scale pilot unit was constructed to feed pulverized coal by down-draft entrainment in oxygen and steam at a throughput rate up to 45 lb of coal per hr. A synthesis gas of low carbon-dioxide content, containing 90 per cent monoxide and hydrogen, was made from low-grade coals, and gas-output rates as high as 600 cu ft of carbon monoxide-hydrogen mixture per cu ft of generator volume per hr were obtained. The process permits recycling the residue coal for further gasification.

Describing operation of the apparatus and modifications made during the development of the laboratory equipment, the Bureau report also offers theoretical data on the mechanism of pulverized-fuel gasification.

Another phase of gasification tests covered by this report showed that production of synthesis gas is possible from such unreactive substances as high-temperature coke containing 23 per cent inert material. This conclusion was based on a 31-hr run in an experimental pilot unit constructed to study underground gasification of coke walls with oxygen and highly superheated steam.

The report contains tables of operating data and illustrations of equipment and flow diagrams.

A free copy of Report of Investigations 4742, "Laboratory-Scale Work on Synthesis-Gas Production," may be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa.

Underground Gasification

MORE than two years of experiments by the Bureau of Mines and the Alabama Power Company at Gorgas, Ala., show that gases resulting from burning unmined coal may offer a low-cost fuel for generating electric power, the Department of the Interior announced recently.

A gas turbine driven by hot product gas resulting from the underground burning of coal was operated at Gorgas for a short time, for the first time in this country, it was reported.

Meanwhile, James Boyd, director of the Bureau of Mines, disclosed plans for a new experiment at Gorgas in converting coal into gas underground. This project is an attempt to utilize coal without mining it. One of the objectives is production of synthesis gas or hydrogen, a preliminary, and up to now relatively expensive, step in converting coal to gasoline, oils, and chemicals.

About 8000 tons of coal underlying between one and two acres of ground at Gorgas have been burned to date from a single initial passage prepared at the start of the experiment. Entries were driven into a coal bed and connected to the surface by large boreholes through which air was admitted and the product gases withdrawn. No difficulty was found in burning the coal from an initial underground opening, and in conducting subsequent operations from the surface.

Among other things, the test program at Gorgas has demonstrated that a hot gas suitable for operating a boiler or a gas turbine can be produced continuously by burning coal in place. Temperatures above 2000 F are readily achieved, Bureau officials report. In one section, operated for 16 months, the total heat in the gas reached a maximum for the eighth month of about 70 per cent of the heating value of the coal consumed. Gas with a heating value up to 150 Btu per cu ft was obtained for short periods and gas of 40 to 80 Btu was produced for periods up to eight or ten days, the heating value deteriorating after that time.

For the new experiment, said Director Boyd, it is proposed to open up a deeper coal seam, using electric or hydraulic methods of opening passages between vertical boreholes. Bureau officials expect that the new procedure will improve the contact between the air and the coal faces underground and permit better control. If this is successful, it will be possible to produce a gas of relatively high heating value (80 to 100 Btu per cu ft) without deterioration after a few days' operation, thus overcoming the difficulty encountered in previous experiments. Construction of the new unit will begin at once.

Pioneer work on the electric method already conducted in this country by the Sinclair Coal Company and the Missouri School of Mines has shown that connections can be made underground without manual driving of entries, according to the Bureau.

Further technical information on underground gasification can be obtained by referring to the article, "Underground Gasification—An Account of Experiments on Coal Conducted at Gorgas, Alabama," by Milton H. Fies and W. C. Schroeder, which appeared in the February, 1948, issue of MECHANICAL ENGINEERING, pages 127 to 135.

Microwave Communication

MICROWAVE radio is already offering competition to the long lines of telephone and telegraph poles which have for years characterized the American countryside, according to the *Industrial Bulletin* of Arthur D. Little, Inc., for February, 1951. A few intercity microwave relay links have been carrying television-network programs, telegraphy, and long-distance telephone conversations for some time, and more are planned. The large dish-shaped microwave antennas and flat reflectors atop tall buildings or towers are almost impregnable to storm damage and the system furthermore costs less to install than open-wire lines. A recent review by Leo G. Sands, in *Radio and Television News*, discusses many of the technical problems and advantages of microwave communication.

The very short, or "micro," radio waves behave much like light; they can be reflected by a "mirror" and focused into a narrow beam aimed at the intended receiver for essentially private communication. The microwaves are actually much longer than light waves and the focusing reflectors must be correspondingly larger; an automobile headlamp reflector may be a few inches in diameter, but a microwave reflector may be four to ten feet. Like light, microwave energy is mostly reflected or absorbed by solid objects in its path and the microwave transmitter must see the receiver. Whenever the receiver is beyond the horizon, relay stations on high towers pass the message on. Usually the "hop" between stations is from 15 to 50 miles, depending on the contours of the land and the heights of the antennas; at least 50 ft of clearance above trees is usually desirable.

Ideally, a relay station would consist of receiving and transmitting antennas back to back with an amplifier between them to "boost" the signal before it is passed along. As yet, however, amplifiers effective at microwave frequencies are not available, and various ingenious devices are used to overcome the need for a complete receiver and transmitter for each direction of transmission. Commercial success depends largely on the effects of such simplifications on cost and reliability.

Microwave communication was used experimentally several years ago across the English channel. Only since the war, however, have commercially practical sources of super-high-frequency radio energy been available, and only during the last two years have complete systems been built at competitive prices. Several groups of frequencies in the microwave region have now been allocated by the FCC for public and private communications.

A microwave link can accommodate much more information than can a telephone line or a standard radio link. In television transmission, this characteristic is essential, for the amount of information conveyed by a television signal in a second is about a thousand times greater than that carried in voice communication. Ordinary telephone wires are useless for television; only the coaxial cable has enough capacity to compete with the microwave system. For other types of information, the microwave link (or the coaxial cable) can carry a large number of separate channels, such as several voice conversations, musical programs, and telegraph messages. A microwave system has been operating to augment and replace normal wire facilities between New York and Philadelphia since 1945, and in 1948 the network was extended to Washington and Pittsburgh.

There is also a growing demand for microwave equipment by oil companies, electric-power suppliers, and railways. In addition to telephone and telegraph circuits, these microwave links carry information from and to instruments for remote control of unattended pumping stations, substations, and signals. One railroad's new system provides for a train-dispatcher's telephone, a party-line message telephone, a local party-line telegraph circuit, and four through telegraph circuits. Another railway microwave system will provide eight voice channels, and a large oil company will install a similar system along 400 miles of pipe line. The Pennsylvania Turnpike has under construction a microwave system across the state to control the maintenance and policing of the highway. The Bonneville Power Administration is planning a vast microwave system to blanket the State of Washington.

Construction of new intercity pole lines seems likely to diminish in importance. A microwave link has been estimated to cost \$400 to \$800 a mile, while an open two-wire line on poles costs from \$800 to \$1500 a mile. As systems become simplified and standardized, it seems likely that they will more and more relieve the pole lines, especially for through trunk service.

Gas Auto Engine

HOW a standard automobile can run on ordinary household gas was demonstrated recently at the Polytechnic Institute of Brooklyn as a feature of the first open-house exhibit of its laboratories and shops in ten years.

The demonstration of a possible automobile engine of the near future was staged by the department of mechanical engineering in its Heat Power Laboratory.

Prof. Jerome Bartels, Mem. ASME, who conducted the demonstration, showed with a stock Ford V-8 engine, on which only the carburetor had been changed, that the use of ordinary household gas as a fuel produces a performance in horsepower output and efficiency comparable to that of gasoline.

Recent tests have shown that internal-combustion engines, in general, can be effectively operated with propane or butane bottled under high pressure (1500 psi) as a liquid and expanded through a suitable throttle valve into a gas where it is inducted into the cylinder.

According to the Polytechnic scientists, the advantages inherent in such a system are numerous. The most outstanding advantage is that these gaseous fuels have higher octane ratings than do ordinary gasoline. This permits applications of higher compression ratios resulting in higher engine efficiency without destructive "knock."

Another advantage of these fuels is cleaner burning, which leaves less harmful carbon deposits than gasoline. Also, being gaseous in nature they do not wash away the lubrication film during cold-weather operation.

Another important aspect of the use of the gaseous fuel is the fact that a refrigeration system is built into the engine. As the liquid passes through the throttle valve, heat is absorbed from the surroundings as the fuel becomes a gas.

The use of gaseous fuel in refrigerator trucks presently is being studied to see whether the low temperatures surrounding

the throttle valve can be efficiently utilized in a complete system connected to a refrigerating unit in the trailer.

In a second demonstration the mechanical-engineering department showed the effects of varying the compression ratio of the ordinary spark-ignition engine. Using the Co-operative Fuel Research engine it was shown how knock can be reduced at high-compression ratios by the use of high-octane fuel.

A stroboscopic setup to show the actual formation of the spray pattern being emitted through a typical nozzle, used for fuel injection in modern Diesel engines, also was demonstrated.

Coal Cleaning

MECHANICAL cleaning of bituminous coal mined in the United States rose from only 5 per cent of the total production in 1927 to 35 per cent in 1949, according to the Bureau of Mines, United States Department of the Interior.

In 1927 only 28 million tons of coal passed through the mechanical cleaning plants to separate the impurities, compared with 154 million tons in 1949.

Statistical data presented by the Bureau also reveals that over a 22-year period the number of mechanical cleaning plants increased from 236 to 571. The average output per plant increased from 122,000 tons to 269,000 during this time and the amount of refuse handled rose from 3 million tons in 1929 to 31 million in 1949.

The Bureau's report gives details on the growth of mechanical cleaning of coal in this country, including tables and charts showing the coal cleaned by types of equipment, a breakdown of plants and tonnages by States, and explanations of the various methods of cleaning, and other information.

A free copy of information circular 7591, "Statistical Data on the Mechanical Cleaning of Bituminous Coal in the United States," by R. L. Anderson, may be obtained by writing to the Publications Distribution Section, Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa.

50,000-Ton Hydropresses

THE two largest and heaviest hydraulic presses ever devised will be built by the Loewy Hydropress Company of New York, N. Y., during 1951, for the U. S. Air Force, according to the February, 1951, CADO *Technical Digest Data*.

These presses will have a capacity greater than 50,000 tons. AMC spokesmen state that the 50,000-ton capacity of the huge machines is far in excess of any other hydraulic press known. At present, the world's largest die-forging press, with a capacity of 33,000 tons, is operated by the Russians, along with an extrusion press of 13,000-ton capacity, as partial payment of war reparations.

It is expected that the new giant presses will be put into operation by the spring of 1952.

Metal blanks, or billets, can be fed into the press, and by the mere push of a series of buttons a complete aircraft component such as a wing is fabricated. The press shapes the metal as though it were paper into a desired form in one quick operation.

Wing sections, which are now fabricated from many separate parts fastened with countless numbers of rivets, will become a thing of the past. The new presses not only will save many valuable man-hours, but will also produce parts which are stronger and aerodynamically "cleaner" than aircraft structures of the past. In addition, savings in metal, due to the elimination of scrap, will be tremendous. The pay-load capacity and effective range of future aircraft also will be greatly increased, because closed die-forging and extrusion methods produce components of lighter weight.

The Air Force's order for its new supermachinery is another step forward in the large press program sponsored by the Department of Defense and endorsed by the National Security Resources Board and the Munitions Board. The purpose of this program is to provide new and improved facilities for the plastic forming of metals, specifically by methods of closed die forging and extrusion.

Foreign Small Plants

ESTABLISHMENT of plants in foreign countries by small businessmen was urged by James D. Mooney, Mem. ASME, chairman of the Board of Technical Managers, Inc., New York, N. Y. He said there was a great potential for the American small business community abroad, particularly in many of the supplier industries. Mr. Mooney spoke at the 1950 ASME Annual Meeting before a Management Division Session.

He stated that many companies have found it possible to obtain returns from their business abroad in currencies or commodities for which by barter, arbitration, or multiple currency exchanges, they are able to salvage a good portion of their net returns. Actually, a number of companies specializing in just such transactions have sprung up since the end of the war and because of managed currency, blocked currencies, and the dollar gap, an amazing amount of barter trade has taken place, in Europe particularly.

Mr. Mooney pointed out that many foreign governments have become sensitive to the problem and some countries have enacted new laws which make investments much more attractive to the American small businessman.

In the automotive industry, for example, there is a great deal of business awaiting American manufacturers of spark plugs, carburetors, generators, and other components which could easily be made overseas for supplying American automobile companies who have plants abroad and the foreign automobile plants as well, he said.

In most instances it does not take a large investment to set up a small plant to process such components abroad. Such business need not, of course, be limited to the automotive industries.

Mr. Mooney said that management problems of a plant overseas are similar to those of a plant in the United States. However, in addition to financial considerations, difficulties may arise in regard to personnel and sometimes special problems result from language barriers, local customs, local government regulations, and high taxes and customs duties.

Perhaps the largest single problem faced by an American company operating a small plant overseas is the personnel problem, Mr. Mooney stated. Some companies adopt the policy of hiring all supervisory personnel for the plant from the United States; others bring in top-management personnel only and train local people for all other jobs.

But most companies import all supervisory personnel over a determined level from the United States and train local supervisory personnel, such as shop foreman and assistant foremen.

No matter what the company management may decide, it is extremely important in any overseas plant to include the indoctrination of all local personnel, whether supervisory or labor, to a much higher degree than that required in the U. S.

The answer to the personnel problem becomes a matter of expediency because it is at times difficult to find Americans who are qualified for the jobs involved and who are willing to go overseas for long periods of time.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Thread-Rolling Status

Developments and Present Status of Thread Rolling, by A. Bradford Reed, Reed Rolled Thread Die Company, Worcester, Mass. 1950 ASME Fall Meeting paper No. **50—F-19** (mimeographed).

THE development of thread rolling from its origin to the present, with particular emphasis on the developments of the last few years, is traced.

The reciprocating flat-die machine, which was the only type of thread roller being produced commercially, was and is ideally suited to automatic threading of large quantities of small solid parts, but it is not readily adaptable to hollow parts, parts over 1 in. in diam, parts with threads less than one or more than 10 diam long, and parts with coarse blunt threads, such as acmes.

To meet the requirements of such parts, as well as to provide greater ease in obtaining accuracy in precision fasteners, interest was revived in the various types of rotating cylindrical-die machines that had been invented nearly 100 years before, but never commercially developed. In the late 1930's a machine resembling a centerless grinder, employing two cylindrical dies and a work rest, was developed in Germany, where it was used for the production of aircraft fasteners. In the early 1940's this machine was copied and improved in England and America. Other machines employing three cylindrical dies were simultaneously being developed in this country.

These rotating cylindrical-die machines are now being built in several styles and sizes for both in-feed and through-feed rolling, and can be adapted to a wide variety of work.

Since the end of the war improved dies and holders have stimulated the use of thread rolling on automatic screw machines where their ability to operate at high speeds and behind shoulders has increased automatic-screw-machine production and eliminated secondary threading operations.

Interest is turning again to the type of rollers employing a cylindrical die with one or more co-operating concave segments. Though machines of this type are not yet in operation on a large scale, there are indications that they may be developed to handle work of the type now commonly threaded in reciprocating flat-die-type machines at considerably higher production rates.

Major advantages cited for the thread-rolling process include: (1) Speed and economy, (2) material savings, (3) accuracy and uniformity, (4) smooth finish, (5) increased strength, and (6) versatility.

Like all other processes, thread rolling has its own inherent limitations. For example, it cannot be used to form threads on hard materials. It is not suitable for threading nonductile materials. Unless blanks are held to reasonably close limits, and dies are squeezed tight enough to top the threads, a seam or valley will frequently show in the crest of the thread. If threads are deep in relation to the diameter, distortion of the part at the juncture of the threads and the shank is sometimes a problem. If proper dies and blanks are used, diameter, lead, and thread form are to a degree, foolproof; but roundness, drunkeness, and slivers are not, and must be guarded against in the setup. As no metal is removed in the rolling process, the user must start with just the right amount in the blank. If the OD's of the thread and of the adjacent body of the part are required to be equal, then a preliminary operation is required to reduce the blank to rolling diameter.

Heat Transfer

Analysis of Stresses and Displacements in Heat-Exchanger Expansion Joints, by Glenn Murphy, Mem. ASME, Iowa State College, Ames, Iowa. 1950 ASME Annual Meeting paper No. **50—A-133** (mimeographed).

IN the design and investigation of heat exchangers the evaluation of the stresses and displacements that occur in expansion joints presents some difficulties because the joint is normally part of a closed and therefore statically indeterminate system, and because of the variety of shapes utilized for expansion joints.

This paper presents a procedure for the analysis of stresses and displacements in an expansion joint, when the latter is

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assumed to be a surface of revolution. The analysis as presented employs a method of successive approximations, but, in general, the solution will be rapidly convergent. Possible thermal gradients in the joint are not included in the analysis as given, but may be introduced in the solution.

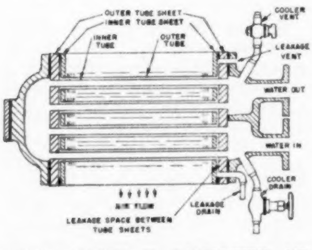
Since the joint is part of a statically indeterminate system, the analysis for stresses and displacements must be based on the equations of equilibrium, and considerations of the changes in the geometry of the joint and assumed properties of the material. It is shown that the equations of equilibrium for a longitudinal strip through the joint may be reduced to the same form as the differential equation for a planar frame with a variable load. The conjugate frame analysis is then applied to evaluate displacements. Once the displacements are known, stresses may be evaluated.

A Leakproof Heat Exchanger, by J. T. Cullen, General Electric Company, Schenectady, N. Y. 1950 ASME Annual Meeting paper No. **50—A-125** (mimeographed).

THIS paper describes a method for preventing the two fluids of a heat exchanger from mixing with each other in case of tube leaks.

There are so many factors which contribute to tube failures, such as poor water supply, excessive vibration, incorrect installation, improper venting, tube flaws which pass initial inspection but open up after being in operation a short time, and other items over which the designer very often does not have control, that it is practically impossible to eliminate the tube failures themselves.

The heat exchanger described in this paper is used for cooling the air stream which is recirculated in electric motors and generators and is commonly known



TYPICAL SECTION OF DOUBLE-TUBE AIR COOLER

(Leak in the water carrying inner tube goes to the space between the inner and outer tubes and then to the leakage space and harmlessly out the leakage drain.)

as a double-tube surface air cooler. The heat is carried away by the cooling water. This is a specific application. The heat exchanger can be used with other fluids and on other applications.

The double-tube cooler is practical and has a definite application especially where a leaky tube could cause excessive damage, shut down expensive apparatus, or endanger life. It is ideal for preventing one fluid from contaminating another where such a requirement is necessary in a heat exchanger. The design is not absolutely leakproof but one in which the possibility of interleakage is remote.

Performance and operation beyond the present range of experience have not been investigated.

Aluminum Alloys in Heat-Exchanger Construction, by E. G. Kort, Mem. ASME, and J. S. Hamilton, Aluminum Company of America, New Kensington, Pa. 1950 ASME Annual Meeting paper No. **50—A-123** (mimeographed).

ALUMINUM alloys are used in the design of heat exchangers and other process equipment. These alloys are inherently resistant to a large number of organic and inorganic materials. Aluminum heat-exchanger tubes of the Alclad variety ar. designed to resist action of cooling waters. This paper covers such factors as corrosion resistance, ASME Code considerations, service history, and others which are important to the engineer.

It is pointed out that condensers and heat exchangers constructed with aluminum alloys have shown an excellent performance record over many years. The problem of designing with these alloys is currently difficult because of the status of the various construction codes. In the past few years the need for inclusion of aluminum within the structure of the ASME Unfired Pressure Vessel Code has become increasingly apparent. Various ASME Committees are currently working on a nonferrous code, and it is to be hoped that they will arrive at a workable solution in the near future. During the interim period it is advisable that both manufacturers and users fully investigate all local and state regulations before proceeding to design or build vessels to these regulations.

Gas-Turbine Power

Optimum Design of Gas-Turbine Regenerators, by W. M. Rohsenow, Jun. ASME, T. R. Yoos, Jr., and J. F. Brady, Massachusetts Institute of Technology, Cambridge, Mass. 1950 ASME Annual Meeting paper No. **50—A-103** (mimeographed).

IN some heat-exchanger applications such as liquid-to-liquid coolers, the pressure drop is not significant; however, in automobile and aircraft radiators and particularly in gas-turbine regenerators this energy loss is undesirable. In gas-turbine cycles a maximum rate of heat transfer is desired in order that the size of the heat exchanger be a minimum; and minimum pressure drop or friction loss is desired in order that the plant fuel flow and, therefore, operating cost be a minimum. Recently developed types of extended heat-exchanger surfaces use fins, pins, and other turbulence promoters to increase the heat-transfer rate, but these devices may also tend to increase frictional effects.

The sole purpose of a regenerator in the gas-turbine cycle is to increase its efficiency or decrease its fuel rate. It does not increase the net power output of the plant; in fact, the net power is decreased slightly because of increased pressure losses and decreased fuel rate.

For a given set of cycle conditions it is desirable to have a regenerator of smallest weight, volume, and costs. In general, only one of these qualities can be obtained in any one design. Probably the most essential quality for the aircraft power plant is minimum weight; for marine propulsion, minimum volume; and for the land power plant, minimum cost.

This paper presents a method for the design of minimum-volume and minimum-weight regenerators for use in a given gas-turbine cycle when the friction loss in the regenerator and the regenerator effectiveness are fixed. The effect of varying regenerator effectiveness and friction loss on the dollar saving, weight saving, and volume saving of a regenerator is also to be investigated.

Convenient Gas Properties and Charts for Gas-Turbine Calculations, by Chapman J. Walker, Mem. ASME, General Electric Company, Schenectady, N. Y. 1950 ASME Fall Meeting paper No. **50—F-28** (mimeographed).

IN 1940 the author's company intensified its engineering activity in the gas-turbine field, whereupon it immediately became apparent that a systematic compilation of the properties of air, combustion gas, and other gas-turbine fluids was needed, in such form as to be

convenient for everyday use in turbine and compressor calculations and for gas-turbine cycle analysis, and within engineering accuracy ($^1/_{10}$ of 1 per cent) over a wide range of variables. At about the same time, a large amount of spectroscopic specific-heat data became available, and furnished the basis for temperature-enthalpy and pressure ratio-isentropic energy relations. The chief requirement was for a system of calculating and plotting the data in convenient form for everyday use, with the required accuracy.

The author was enthusiastic about working fluids whose chief properties were independent of pressure, and devoted much time to the consideration of various systems of presenting such data for engineering use. The resulting charts have been in daily use for nearly ten years. The enthalpy, isentropic energy, and combustion-temperature-rise charts have been especially convenient.

Petroleum Mechanical Engineering

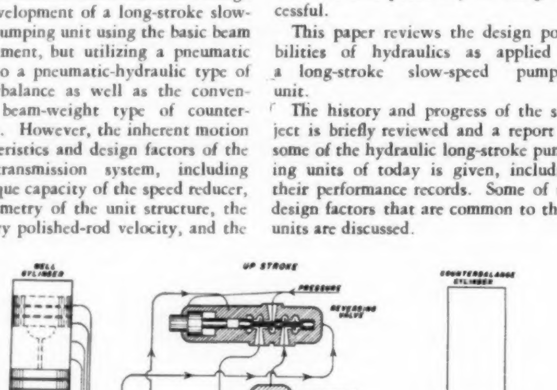
Design of Hydraulic Long-Stroke Pumping Units, by P. J. Donnelly, W. C. Norris Manufacturer, Inc., Tulsa, Okla. 1950 ASME Petroleum Mechanical Engineering Conference paper No. **50—PET-21** (mimeographed).

THROUGHOUT the mechanical development of the beam pumping unit there has been a definite trend toward the use of longer stroke lengths and slower pumping speeds in an effort to improve the efficiency of the sucker-rod pumping system. Considerable successful work has been done on the design and development of a long-stroke slow-speed pumping unit using the basic beam arrangement, but utilizing a pneumatic and also a pneumatic-hydraulic type of counterbalance as well as the conventional beam-weight type of counterbalance. However, the inherent motion characteristics and design factors of the power-transmission system, including the torque capacity of the speed reducer, the geometry of the unit structure, the necessary polished-rod velocity, and the required effective counterbalance, still presented a number of vexing mechanical and economical problems.

Within limits, these problems have caused the design engineer to seek out other types of power-transmission systems to pump oil wells, as well as those that could be better adapted to a long-stroke slow-speed pumping unit for sucker rods. Of the many different forms and combinations tried and considered, that of hydraulics seemed to offer the best possibility of being successful.

This paper reviews the design possibilities of hydraulics as applied to a long-stroke slow-speed pumping unit.

The history and progress of the subject is briefly reviewed and a report on some of the hydraulic long-stroke pumping units of today is given, including their performance records. Some of the design factors that are common to these units are discussed.



FLOW DIAGRAM OF LONG-STROKE PUMPING UNIT GENERALLY REFERRED TO AS THE WEIGHT HYDRAULIC COUNTERBALANCED UNIT

Fatigue Testing and Development of Drill Pipe-to-Tool Joint Connections, by William S. Bachman, Hughes Tool Company, Houston, Texas. 1950 ASME Petroleum Mechanical Engineering Conference Paper No. **50—PET-23** (mimeographed).

ONE of the major problems in the development of rotary drill stem has been to eliminate fatigue failures in service at the last point of engagement between tool joint and drill pipe. In recent years this type of failure has been greatly reduced by the use of better-designed tool joints. These newer designs are the result of both laboratory and field experience.

In this paper results from fatigue tests on full-size $4^1/_2$-in. drill-pipe connections are given. These factors which affect fatigue strength of a drill-pipe connection are also discussed, and there is included a sample fatigue-strength problem to demonstrate how the higher fatigue stress values of the newer-type connections have practically eliminated failures at the tool joints.

The drill pipe, which was developed and most commonly used in the oil field today, is known by API specifications as grade D. It has a minimum tensile strength of 95,000 psi and yield strength of 55,000 psi. Generally, it will exceed these limits.

Observations of the Effect of Time on Physical Properties of Small Tanks, by T. L. White, The Commercial Shearing and Stamping Company, Youngstown, Ohio. 1950 ASME Petroleum Mechanical Engineering Conference paper No. **50—PET-26** (mimeographed).

NUMEROUS tests made over a period of years on spherical vessels, each composed of two hemispheres, have developed a number of interesting points, one of which is the changes in physical properties of the steel over a period of time.

Many of these tests have been made in conjunction with the program of the Pressure Vessel Research Committee of the Welding Research Council, with the co-operation of The Commercial Shearing and Stamping Company.

The hemispheres considered in this paper are all of the same size and specification and are designed for vessels to store liquefied petroleum gas, chiefly Propane, at atmospheric temperatures. They were all cold-formed, and after being assembled and welded into tanks were hydrostatically tested in a similar manner using a hand pump to develop the pressure. They are made of open-hearth, semikilled, flange-quality steel

conforming to ASME Specification SA-285, grade C.

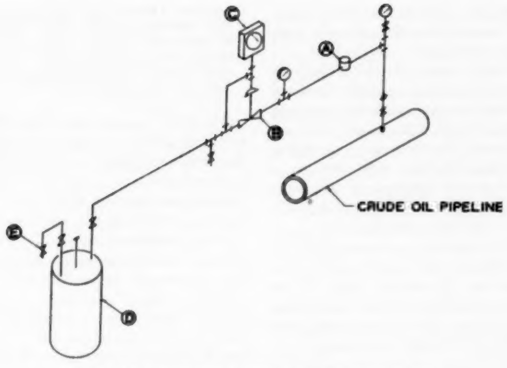
The principal observation derived from these tests is that over a period of time the vessel becomes more uniform in its resistance to deformation. The portions of the shell which have undergone high deformation tend to increase in ductility while the weaker point at the joint where the heat of welding has lowered the physical properties has become stronger.

Operation of Submarine Pipe Line and Production Facilities in the Gulf of Mexico, by G. W. Osborne and F. S. Bird, The California Company, Gulf Coast Division, Harvey, La. 1950 ASME Petroleum Mechanical Engineering Conference paper No. **50—PET-31** (mimeographed).

THE design of offshore producing involves volume of fluid, method of transporting to shore, physical and chemical characteristics of the oil, spacing of drilling structures, number of wells drilled per structure, distance to shore, and many other factors. This paper primarily discusses existing facilities at the Bay Marchand Field which is located about 60 miles south of New Orleans, and about two miles offshore in water depths of 28 to 36 ft. When design of the existing facilities was initiated the status of the field development was as follows: Four structures, A, B, C, D, had been constructed. Three wells had been completed on B, five wells had been completed on C, A was dry, and two rigs were drilling on the D structure.

All wells were flowed to the A structure through 2-in. submarine pipe lines. The oil was separated on the A structure and then pumped to shore through a 4-in. submarine line. Separation and pumping facilities were originally installed on the A structure, because it was available after serving its purpose as a drilling structure and was an economical solution to the then current production problem. With initiation of drilling on the D structure, the overloading of the production facilities on the A structure was foreseen. The production facilities on the A structure could not be enlarged without enlarging the structure itself, because all the structure area was utilized. Experience gained from operation of the facilities on the A structure indicated a need for equipment which would allow the oil to be transported from the offshore well to the shore terminal with a minimum of intervening steps, and which would be completely reliable and capable of operating for extended periods of time in all normal weather.

Therefore desirable design characteristics were compiled for production facilities to supplant the A-structure facilities which required constant attendance, and which the oil field had outgrown. The desirable characteristics compiled for incorporation into the design of the facilities are outlined and discussed in the paper.



PORTABLE AUTOMATIC SAMPLER IN ORIGINAL FORM

(*A*, Grove mity-mite pressure-reducing valve; *B*, Research Control Instrument Company diaphragm control valve; *C*, Dickson minicorder; *D*, 10-gal sample container; *E*, flow-control needle valve.)

A Portable Automatic Sampler, by W. E. Roads, Service Pipe Line Company, Tulsa, Okla. 1950 ASME Petroleum Mechanical Engineering Conference paper No. **50—PET-30** (mimeographed).

A SPECIAL-PURPOSE automatic sampler has been developed to obtain reasonably representative samples of crude oil as it flows through pipe lines near small field-gathering stations and at junctions where field lines inject into main trunk lines. This paper describes a self-contained constant-rate sampler capable of automatically taking crude-oil samples at flow rates as low as 1 cc per min, without need of external connections to a power source.

Original intent was to connect the oil-inlet side of the sample container directly to the sample tap on the pipe line, and to control the flow of water from the container—assuming that 1 cc of crude oil would enter the container to replace each cc of water that was displaced therefrom. Control on the water-outlet side would be obtained through the use of a pressure-reducing valve, a diaphragm control valve, and a flow-control needle valve. This arrangement would keep the sample at line pressure and prevent vaporization of the light ends in the crude. However, it would require the sample container to withstand full line pressure, resulting in a heavy and expensive container for 1000 psig operation. In order to save weight and cost of fabrication the sample containers were designed for a working pressure of 50 psig, necessitating pressure reduction between the pipe-line connection and the sample container. In order to insure satisfactory operation of the pressure-reducing and pressure-control valves, filtering of the crude would be required. Filtering would remove a portion of the BS content from the sample; however, this was not considered objectionable since BS determinations were not of primary interest in the crude analysis to be made.

Cooling Towers

Some Economic Factors in the Selection of Cooling Towers, by A. R. LeBailly, Mem. ASME, Sargent & Lundy, Chicago, Ill. 1951 ASME Spring Meeting paper No. **51—S-5**(mimeographed).

COOLING towers are subject to performance degradation due to age. Chemical deterioration will slowly affect the wood fill and structures with some local waters. More recently, biological deterioration has been encountered in several locations and investigation of the corrective measures to be applied are now in progress. The designer should allow for such degradation margin in the cooling-tower specification.

The heat load used in the design should provide a margin to permit operation at full capability of plant generating equipment.

Closer approach to the maximum normal wet-bulb temperature should be used

for design, especially in locations where the peak load is coincidental with high wet-bulb temperature.

An economic study should include an evaluation of the extra turbine capacity available due to better vacuum, resulting from a closer approach design. A comparison based on the yearly operating cost and fixed charges only without a consideration of the extra available capacity would be misleading and would not lead to the optimum selection.

It is the engineer's responsibility to provide a margin in a cooling-tower design equal to the margin used in the generating equipment and insure performance at the plant at rated capacity during the expected life of the unit.

Cooling Towers for Steam-Electric-Station Economic Applications, by Louis Elliott, Mem. ASME, Ebasco Services Inc., New York, N. Y. 1951 ASME Spring Meeting paper No. **51—S-6** (mimeographed).

A METHOD of making an economic comparison between the use of a cooling tower and a direct-condensing arrangement for a steam station is outlined. The method is illustrated by analyzing a specific problem.

If it is assumed that steam flow to throttle at maximum output and with standard throttle steam conditions is reasonably constant, generation will vary with changes in exhaust back pressure. Maximum capability is then affected in about the same degree as is plant economy. In the particular case cited, maximum plant capability of a cooling-tower plant as compared with a direct-condensing is penalized between 2 and 3 per cent.

The differentials between the two types of plants, in fuel use and in capability, may be combined in any way desired. Cost of fuel is a major element of operating expenses, and loss of plant capability may be evaluated as a fixed-charge component of total energy cost.

A cooling-tower plant may be considered as carrying slightly higher depreciation and maintenance expense than a direct-condensing. Certain data have recently been developed as to delignification and other deterioration of wood in a cooling tower, which tend under some conditions to shorten life. However, a cooling-tower installation is frequently economical, when large expenditures for storage reservoirs, for intake structures, or for long transmission lines, are avoided by its adoption.

Cooling-tower performance, location and orientation of towers, and problems requiring research, are briefly discussed.

Selection, Operation, and Maintenance of Industrial Cooling Equipment, by Howard E. Degler, Mem. ASME, The Marley Company, Inc., Kansas City, Kan. 1951 ASME Spring Meeting paper No. **51—S-7** (mimeographed).

RECENT water crises have brought to public attention basic water shortages that engineers have predicted for years. Conservation and re-use of water have become a necessity in many areas. Water can be purified, cooled, and re-used.

Large industrial water users are power plants, manufacturers of paper, petroleum products, rayon, linens, textiles, lactose, sugar, explosives, hydrogen, rubber, steel, etc. Requirements are frequently in excess of 300 lb of water per lb of finished product. Water usage has doubled in the past decade; hence selection of cooling equipment becomes more important as power demands increase, industries expand, and new processes are perfected.

Mechanical-draft cooling towers can evaporatively cool water to a temperature approaching the wet-bulb temperature of the ambient air. This evaporative method requires less than one per cent evaporation of the water circulated to economically dispose of the heat load.

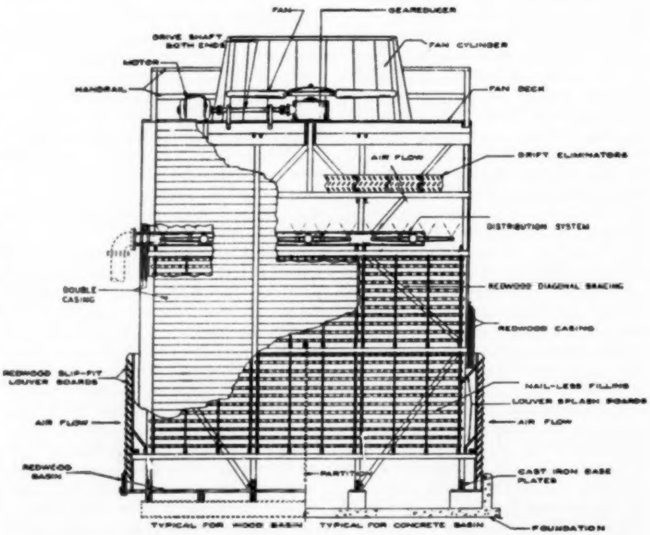
Air-cooled finned-tube exchangers are having increased acceptance and usage for "high-level heat removal" (for example, above 140 F referred to 100 F dry-bulb air), where water is scarce, expensive, and/or badly polluted; small space requirements and easy control are other features.

The performance and life of any piece of cooling equipment is directly dependent upon its inherent qualities, type of service, severity of operation, general care and maintenance, and climatic environment.

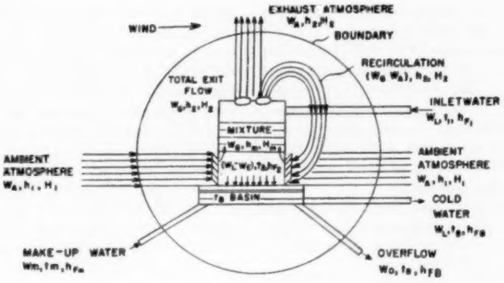
It is impossible to formulate any set of recommendations that would definitely establish a given cooling method as the most suitable for any particular installation. The anticipated performance of a proposed installation must be completely analyzed, and the final selection frequently becomes a matter of engineering compromise and personal preference. It is significant that as the need for water conservation increases, the manufacturers of cooling equipment have been accumulating a great reservoir of experience by continuously making more economical units and more highly specialized applications.

Recirculation in Cooling Towers, by Joseph Lichtenstein, Mem. ASME, Foster Wheeler Corporation, New York, N. Y. 1951 ASME Spring Meeting paper No. **51—S-8** (mimeographed).

RECIRCULATION can be defined as an adulteration of the atmosphere entering the tower by a portion of the atmosphere leaving the tower, thereby increasing the enthalpy of the entering mixture above that of the ambient atmosphere.



SECTION THROUGH AN INDUCED-DRAFT COUNTERFLOW WATER-COOLING TOWER



TYPICAL COOLING-TOWER INSTALLATION

For simplicity it is assumed that the enthalpy of this portion is the same as the enthalpy of the exhaust atmosphere.

This paper shows that recirculation is a characteristic of the surroundings of a cooling-tower installation and must be considered by the user in his economic calculations and by the manufacturer for the proper selection of a cooling tower to reach a specified cold-water temperature. A knowledge of recirculation factors of installations can be obtained experimentally only by co-ordinated over-all tests on actual cooling-tower installations. The paper develops the methods and equations required for such tests to find the recirculation factor. It then shows how the cold-water temperature is affected by various degrees of recirculation, and how the size of a cooling tower would have to vary if the cold-water temperature is fixed. Finally, the variation of cold-water temperatures with varying wet-bulb temperatures is studied for a series of fixed recirculation factors and it is shown that if the recirculation factor increases with decreasing wet-bulb temperatures, a nearly constant cold-water temperature all year round may result.

Foundry Production

What Is Foundry Sand? by Douglas C. Williams, The Ohio State University, Columbus, Ohio. 1951 ASME Spring Meeting paper No. **51—S-23** (mimeographed).

THE question "What Is Foundry Sand?" is of importance when one recognizes that between 10 and 70 tons of sand mixtures must be prepared, handled, and molded for every ton of castings shipped. From January through August, 1950, the casting manufacturing establishments in the United States shipped about 11 million tons of castings, which is about one sixth of U. S. capacity for the production of wrought steel. The real capacity of the country is unknown but it appears that the tonnage could be doubled.

The best definition for sand, known to the author, is as follows: Sand is a particle-size classification applied to nonmetallic minerals.

Sand mixtures used in the process for manufacturing castings can be grouped as follows: (1) Naturally bonded sand mixtures which are used "as-mined"; (2) sand mixtures compounded to provide control of properties. The components of each group of mixtures can be the same.

Core sand mixtures are compounded sand mixtures. Sand, silt, and clay-minerals are particle-size classifications of nonmetallic minerals.

"A.F.A. clay" includes material classified as fine silt and clay-mineral but does not give any information as to the distribution of particles of silt and clay-minerals.

In designing the various parts of a sand-handling system it is desirable to consider the density of sands under various conditions such as: Molded sand, 90–110 lb per cu ft; mixed sand, 65 lb per cu ft; and shakeout sand, 85 lb per cu ft.

Sand grains smaller than the 210-micron (No. 70 mesh) size will be angular in shape regardless of source.

Relationship Between Modern Foundry Methods and the Quality of Castings, by F. R. Elliott, Westinghouse Electric Corporation, Springfield, Mass. 1951 ASME Spring Meeting paper No. **51—S-20** (mimeographed).

MODERN methods of foundry operation have contributed greatly to the improved quality of sand castings produced today in every section of the foundry industry.

Methods of molding, handling, and patternmaking have all been developed to a high degree. All of these are important but even more so are methods that are being adopted by foundry management. Foundry management has gradually passed from the hands of people who grew up in the industry, such as molders or patternmakers, into the hands of engineers and metallurgists. Foundry management has graduated from an art to a science.

Building a quality-minded organization is one of modern foundry-management's chief problems. Setting up a quality-control program and enlisting the employees' co-operation involves the establishment of certain fundamentals. Standards of quality should be determined and adhered to firmly. Methods of procedure should be established so both the operator and management definitely know what is to be done and how it is to be done.

Rugged and reliable equipment has been developed for almost every phase of foundry operation. Such equipment has taken much of the hard work out of the foundry and increased production per man tremendously. At the same time it has led to a definite mechanical control of foundry operations which formerly were dependent upon human skill and effort and reliability. Foundry mechanical equipment falls into several categories; handling equipment, molding equipment, pattern equipment, and cleaning equipment. The development of each of these has contributed to casting quality.

No casting can be any more accurate than the pattern from which it is made. Accurate pattern equipment has become a primary requisite of the modern production foundry.

Accurate patterns are of little value unless they are used with good flask equipment. Formerly most flasks were made of wood. Special rolled-steel shapes have now been developed for flasks and they offer a satisfactory compromise between weight and strength.

Some comparatively lightweight cast-steel flasks have also been developed which eliminate some of the complaints regarding the weight of the earlier cast flasks.

Aluminum flasks of the so-called "slip type" have also come into wide use for molding small highly repetitive castings.

Molding machines have been developed to a high degree. For the most part they are operated by air pressure. They can now be equipped with automatic controls which will control and operate each step of the entire machine cycle. Some ma-

chines can be equipped with roller conveyers so the flasks can simply be rolled onto and off the machine with very little effort.

Sand-handling systems which prepare and deliver molding sand to the molding machines also contribute to the making of better castings. The systems usually comprise a series of steel-apron and rubber belt conveyers with the necessary mixers, elevators, magnetic pulleys, screens, and storage hoppers.

Sand-handling systems have led to the almost universal substitution of synthetic sand for natural sand. Synthetic sand is compounded from selected beach sands or similar sands and suitable clays for supplying strength before and after the mold is poured.

In recent years a great deal of study has gone into the methods of gating and feeding. The fundamental principles involved have been carefully investigated by several research organizations who have attempted to establish standard data for the size of gates and feeders and pouring channels.

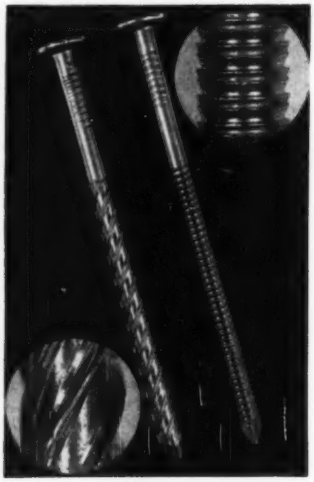
Feeding problems have also led to the development of exothermic and insulating compounds designed to retard the metal in the feeder.

The metallurgical phase of foundry operations has also received extensive study.

Wood Technology

The Nail, an Indispensable Fastener, by E. George Stern, Mem. ASME, Virginia Polytechnic Institute, Blacksburg, Va., 1951 ASME Spring Meeting paper No. **51—S-18** (mimeographed).

ONLY lately nails have been given some of the attention they deserve, although they are in everyday use by almost all manufacturers of wood products. Most of these manufacturers aim at optimum results in their particular fastening problems. The seemingly unlimited number of variables in the design of nails, however, makes it difficult for the nail user to determine which combination of variables he should specify.



TYPICAL HELICALLY GROOVED "SCREWTITE" AND ANNULARLY GROOVED "STRONGHOLD" NAILS

The sizes and types of nails in production and use are numerous. Nails are made of low-carbon, high-carbon, or stainless steel, of aluminum, copper, brass, bronze, chromium, nickel, and silver alloys. Nails are manufactured pointless or with blunt, medium, or long diamond, needle, chisel, duckbill, side or V points. They are made headless or with standard, medium, or large; flat, round, oval, cupped, checkered, or slotted; cone, countersunk, brad, hook, double, or spiral-wire heads. The round, triangular, square, or rectangular-shank nails may be smooth, barbed, etched, twisted, or spirally, helically, or annularly grooved. Grooved-shank nails may be provided with a clearance and/or a pilot. Special-purpose nails may be blued, annealed, tempered; hot or electrogalvanized; copper, nickel, tin, or cadmium-plated; phosphatized or resin coated. Altogether, more than 1000 sizes and types of nails are made on request of the numerous nail users.

This paper indicates the advantages and disadvantages of the foregoing design variables in order to make it possible for the nail user to determine which nail he should use for his specific nail applications.

Every nail used in manufacture and assembly of wood products has a specific purpose. In numerous cases, it may be possible to improve effectiveness and efficiency in nail assembly by taking advantage of the many design variables.

The economies involved may be highlighted by the fact that $^3/_4$ million tons of steel-wire nails were produced in the U. S. during 1948. More than 560 lb of nails are needed just to build a standard-design 50 × 24-ft five-room house with attached garage. The cost of such a quantity of nails amounts to two thirds of one per cent of the total construction cost if plain-shank nails are used and to one per cent if all plain-shank nails are replaced with grooved nails. The effectiveness of such a replacement may be proved by the fact that properly grooved nails may improve, for example, the strength of the conventional unsheathed housing frame as much as four to six times. This may be indicative of the effects attained if advantage is taken of some of the recent developments in the field of nails and nailing.

The Mechanism of Wood Preservation and Wood-Preserving Plants, by J. A. Vaughan, Southern Wood Preserving Company, Atlanta, Ga. 1951 ASME Spring Meeting paper No. **51—S-25** (mimeographed).

THE decay of wood is caused by microbiological organisms commonly known as fungi. Wood may be destroyed, however, by other organisms such as insects and marine borers.

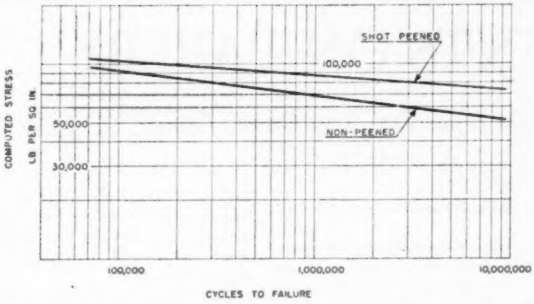
In either case the protection of wood by preservatives must depend upon substances which are toxic or which in some other manner make the wood unfavorable to attack or unattractive to the organism.

Therefore the actual protection of wood by wood preservatives is brought about by chemical and biological processes. The phases entering into the treatment or injection of the preservative into the wood, however, embrace physical and mechanical means which may vary depending upon the result desired. Since much handling is involved in procurement and preparing the wood for treatment it is evident that many mechanical means are employed for this purpose. While most wood-preserving plants combine mechanical and manual operations, there are certain fully mechanical setups for items such as poles and crossties. At a time when labor costs constitute such a large part of production operations, there is greater incentive to further mechanize wood-preserving plants. Some have gone so far as to automatically control the treating operation through mechanical instrumentation.

Machine Design

Shotpeening as a Factor in the Design of Gears, by John C. Straub, American Wheelabrator & Equipment Corporation, Mishawaka, Ind. 1951 ASME Spring Meeting paper No. **51—S-21** (mimeographed; to be published in full in MECHANICAL ENGINEERING).

SHOTPEENING is a definite factor in gear-tooth design. It can be used ef-



FATIGUE CHART OF CARBURIZED AUTOMOTIVE-TYPE SPUR AND HELICAL GEARS, SHOT-PEENED AND NONSHOTPEENED

fectively not only for the accepted practice of increasing bending strength but also, in conjunction with design, for increasing scoring resistance. Empirical methods of determining bending strength and scoring resistance particularly in spur and helical gears are presented. These methods are selected on the basis of data from automotive and aircraft gearing tests.

In general, gear-tooth failure may be grouped into the following three classifications:

1 Tooth breakage, in which an entire tooth or large portion of a tooth is broken out due to bending stress and commonly known as a "fatigue" type of failure.

2 Pitting, which is characterized by pits or small craters in the contacting surface of the tooth.

3 Scoring, sometimes referred to as spalling, scuffing, or galling, is distinctly different from the first two mentioned and is evidenced by a decided roughness on the working tooth flank as though the mating surfaces had seized.

This paper points out some of the advantages of shotpeening in combination with the design of gears as a means of (1) reducing bending failures, (2) reducing scoring failures, (3) reducing weight or space requirements, (4) reducing production costs.

With respect to reducing production costs, the extent of cost reduction would vary considerably for various applications, but it might be of interest to cite an example of what can be accomplished. An estimate of possible reduction was made on the basis of a production machine used for shotpeening large coil springs. Assuming an increase of 10 per cent in allowable stress, the saving in material only, by virtue of decreased size, was estimated at $25 per hr of machine operation after all peening costs were taken into account.

Opportunities in Machine Design, by B. P. Graves, Fellow ASME, Brown and Sharpe Manufacturing Company, Providence, R. I. 1951 ASME Spring Meeting paper No. **51—S-3** (mimeographed).

NEVER has there been a greater demand for the services of machine designers than at present. One need only look at the growth of industry in this country, starting not so many years ago, rapidly accelerating from a period only a few years ahead of World War II, and reaching a peak brought about by today's need for mechanization beyond that ever dreamed or thought possible in industry, agriculture, earth-moving, automotive with its latest ideas of progressive-line continuous manufacturing, jet engines calling for entirely new ideas in machining, textiles, etc.

The most essential characteristics and attributes of one who is going to develop a career in machine design are as follows: Dependability, loyalty, friendliness toward a fellow worker, maturity, independent thinking, adaptability, and last but not least, vision.

The essential prerequisites of a machine designer include mathematics, physics, well-grounded in fundamental principles, self-expression, report writing, extracurricula activities, and mechanics.

Summer employment in shop environment is very important to an engineering student and will be of help in future work.

In order to develop skill in putting thoughts on paper, the young engineer should have some experience in preparing detail drawings under the guidance of a group leader or designer and as he grows in skill, he will advance to where he will be allowed to work up simple layouts of mechanisms under the direction of a designer.

The designer's work is to follow up and develop ideas originating from upper management, sales department's ideas, and a designer's own thoughts.

In this field, as in others, competition will be stiff. There will be men who have natural ability as designers (but not a full education) who have come up through the ranks. Apprentice graduates also have a high standing and among them are some capable men. Co-operative engineering students are another group that are making their mark.

Practically all shops have their own avenues for promotion which depend on their product, make-up, and organization. Usually, advancement in design will be made through the steps of junior designer, designer, assistant director of design, and then director of design. These advancements, of course, depend entirely on ability to perform.

ASME Transactions for April, 1951

THE April issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

Ultrasonic Flaw Detection in Pipes by Means of Shear Waves, by C. D. Moriarty. (50—F-14)

Joints for High-Pressure High-Temperature Piping, by I. H. Carlson and W. S. Black. (50—F-32)

Investigation of Steam Separation in Boiler Drums Through Studies on a Model, by E. A. Farber. (50—F-25)

Flow of a Flashing Mixture of Water and Steam Through Pipes and Valves, by W. F. Allen, Jr. (50—F-27)

Report of Progress on Measurements of Friction Coefficients, Recovery Factors, and Heat-Transfer Coefficients for Supersonic Flow of Air in a Pipe, by Joseph Kaye, J. H. Keenan, and W. H. McAdams. (50—F-13)

Heat Transfer Through Gases at Low Pressures, by R. E. Peck, W. S. Fagan, and P. P. Werlein. (50—F-16)

62,000-Hp Vertical Six-Nozzle Impulse Turbines for the Bridge River Hydrodevelopment, by W. F. Boyle and I. M. White.

An Improved Pneumatic Control System, by R. E. Clarridge. (50—A-100)

Principles of Foundation Design for Engines and Compressors, by W. K. Newcomb. (50—OGP-5)

Analysis of the Exhaust Process in Four-Stroke Reciprocating Engines, by J. D. Stanitz. (50—OGP-4)

Design of Lanchester Damper for Elimination of Metal-Cutting Chatter, by R. S. Hahn. (50—F-11)

Residual Grinding Stresses in Mild Steel, by J. Frisch and E. G. Thomsen. (50—F-10)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Machine Design as a Career

Comment by Colin Carmichael[1]

Those of us on the ASME Machine Design Student Talks Committee who have been trying to tell student branch members something about the opportunities for them in the field of machine design will welcome this paper[2] as a basic reference in planning our own talks.

The author refers in one or two places to the great aversion to drafting. Such terms as "the board" and "pencil pushers" are referred to by many students in a tone of contempt. The author wisely has pointed out that a man with the right qualifications need have no fear of getting stuck on the board and will soon graduate into a more glamorous job. However, the writer likes also to stress the importance of the drafting board as an essential medium of expression for engineers, on a par with speaking and writing. Time limitations in college being what they are, the graduate's fluency in drawing is of a low order—about on a par with his fluency in speaking French after a short course in high school. He is still quite awkward at it, does not feel at home. If he takes a job on the board and progresses from drafting into design, he soon begins to feel at home and becomes less and less concerned with the techniques of the T-square, triangles, and compasses, and more and more concerned with the physical and mechanical characteristics of the mechanisms and parts that are being depicted on the drawing. Adequate experience in drafting is an invaluable asset to any design engineer, and the writer suggests that in our talks to the students we stress the positive values of such experience, in addition to dispelling the fear of getting "stuck on the board" for life.

Another point has to do with terminology. In his paper the author rightly emphasizes the functions of the designer and engineer rather than the titles. However, the titles which men, performing the design function, carry are found to vary tremendously in different companies. In the larger companies it is possible to follow a line of succession from tracers through such titles as draftsman, detailer, section leader, development engineer, project engineer, chief draftsman, assistant chief engineer, chief engineer, director of engineering, and vice-president of engineering. However, a small company may elect to call its handful of engineers almost any one of these titles while expecting them to perform the function of all of them. For instance, the draftsman in a small company may actually do all the design and engineering as well as the detail drawing. On the other hand, a fancier title might well cover duties which seem to be on a lower plane; a chief engineer in a small company might be the only member of the engineering department and might have to do most of his own drafting. Perhaps graduates entering the field might be warned not to jump to conclusions based only on their own guesses as to the meaning of their titles.

In referring to the birth of the ASME Machine Design Division five years ago the author rather modestly omitted to mention his own important part in that event. It was on his initiative that the organization meeting was held in 1945, and he became our first chairman. To his clear conception of the scope of our activities the division owes much of its success.

[1] Editor, *Machine Design*, Cleveland, Ohio. Mem. ASME.

[2] "Machine Design as a Career," by J. F. Downie Smith, Mechanical Engineering, vol. 72, December, 1950, pp. 966–968.

Comment by L. A. Darling[3]

The writer agrees completely with the author that machine design offers attractive opportunities to young engineers which are not fully appreciated in many quarters.

When most students think of machine design as a career they think of working with firms who manufacture and sell machinery, but the fact is that opportunities extend beyond this field. The writer's company does not sell machinery but needs engineers with experience in machine design. As nearly as can be determined, there is an immediate and pressing shortage of machine-design talent throughout the chemical and process industries.

We do not sell machinery but we do, of necessity, design process equipment, the complexities of which have increased enormously during the past few years. The situation has changed since the days when chemicals were made by chemists in wooden tubs where they stirred up a batch of chemicals with a wooden paddle. We now use high pressures, high temperatures, high-power-input agitators, and a great variety of ponderous and heavy high-speed equipment. Judging by experience we have had with purchased equipment, some manufacturers of process equipment could also use some machine-design talent.

The writer believes that machine design offers a promising future to young engineers who have the talent and the interest, and that it offers as good an opportunity to reach high places in the chemical industry as any other field of engineering.

[3] Supervisor, Power, Water, and Maintenance Section, Engineering Department, E. I. du Pont de Nemours & Company, Wilmington, Del. Mem. ASME.

Comment by F. C. Linn[4]

Engineering graduates are loath to take up design work if by so doing they are expected to spend a number of years on the drafting board, first starting as detailers and then ending up after a number of years as designers.

A man who spends his time on the drafting board doing design work in large companies loses contact with other branches of work, even within a given division or department of the company. He ultimately becomes a layout man or has to leave the drafting room to have his abilities properly cultivated and recognized. Most engineering graduates enjoy work in which they come in contact with other men in the company representing various interests, as well as discussing problems with customers. The men on the board seldom, if ever, have much of this type of work.

The drafting room is the main production side of engineering. It transmits

[4] Turbine Engineering Division, General Electric Company, Schenectady, N. Y. Mem. ASME.

the engineering know-how in the form of drawings to the shop for manufacture. We need more trained design engineers who can work with designers to design our machines so that they are technically satisfactory and economical to manufacture. The problem is how to train these men.

It is proposed that consideration be given by industrial concerns to having a program of training of college graduates whereby a specified length of time be designated for a man to be on the board doing detail work, layout work, and then design work on the drafting board, after which he would be placed in developmental or other design work where he would not be confined to a board. By such a program young men can see that they will not be continuously doing work which is as confining as is work on a board, and this training program should appeal to many young men.

One great need in design work is to have design engineers who are capable of freehand sketching. Such work logically could be included within their training period.

The writer presents the foregoing program for training because the advancement of a young engineer to becoming a good design engineer should not rest upon his ability to make good drawings but rather upon his ability to create new equipment or improve upon existing equipment. His drafting training should only be enough to train him in the use of the tools available to him in drafting.

Comment by L. F. Nenninger[5]

The writer believes the average engineering graduate has a misconception of what machine design really is. He thinks of it primarily as a career to be spent entirely on a drawing board. He thinks of a drawing board as being something to be shunned, and it offers nothing but a monotonous future. He arrives at this conclusion when he visits engineering offices, or through his work in them observing the personnel we call "draftsmen."

Now, there is nothing wrong with drafting at all; except the average drafting job in the minds of most people, is nothing else but a glorified clerking job and to many this is so. However, we are talking about machine design and not drafting.

The language of machine design is primarily expressed by drawings, therefore, in order for a machine designer to express himself, drawings must be prepared. An engineering graduate who plans to enter the field of machine design as a career, just like anybody else, must learn the elementary phases of this work. He must serve for a period of time as a draftsman, and learn just as he did in grammar school, before he can express himself completely. How quickly he can pass through this phase of training is entirely within the hands of the individual, and depends upon his ability and aggressiveness.

In order for a machine designer to qualify at his best in his work, he should have a reasonable knowledge of good shop practice if he is to create good machinery later on. Frequently, we find drawings from engineering offices made by people who have no conception of how the part is to be made and, as a result, costs for the machine to be built are very high.

A man who is to follow machine design as a career, aside from the proper training, should have other qualifications if he is to make progress. He should be creative, ingenious, and everlastingly seeking new ways to do things. It is very important that a man have these qualifications irrespective of his practical training and education if he is to make any headway for himself. The more complete the education and practical training are, however, the more can be expected from a man who is the "thinker" type.

As the author so well brought out—the fact is that in the past most of the machine designers have had little or no college training. The need today in our complex life and ways requires more knowledge if one is to succeed in his creative work.

In our company we take an engineering graduate, who has had no practical training, and, expose him to a 2-year program covering various phases of manufacturing, time study, and tool design, in order to have him obtain knowledge on these subjects before we attempt to place him in his job. In our community, we have a university operating under the "co-op" plan in engineering, and here we have an opportunity to take young men during their working period and give them similar training that we would give a college graduate.

No one would question whether or not machine design is a good outlet as a career if he would observe the marvelous manifestation of ideas in everyday life—in business, in the home, in his travels, or wherever he may be—and then realize that all of these things, before they are produced, were in the mind of some man who either himself or through his work with other people created a design before the part could be made. Many of these things are very simple and require but little ingenuity to create; but certainly we must admit that things are becoming more complicated to satisfy our needs and, as a result, require considerably more thought to create the end result than they have in the past. Machines of various types are necessary to produce all of these marvelous products if we hope to sell them at a reasonable price.

To the right man, I know of no better future than machine design as a career.

Comment by C. Higbie Young[6]

The selection of a career by a college graduate is naturally a serious matter, and he should give it very earnest thought backed up by as much information as it is possible for him to obtain.

The author has outlined the possibilities of entering the mechanical-engineering field with a view to engaging in design work. He himself came up through this channel, and though now the writer is teaching machine design, in his younger days he worked in the design department in industry.

There has been some discussion about the difficulty of starting on the drawing board. The writer has no desire to belabor this point but does want to bring to the reader a little experience with which he is familiar. No matter where the young graduate starts, it will necessarily be at a low level. But no matter where he starts it will not mean that he has to remain at that level. How long it takes him to get up to the higher levels and how high in his organization he can go depends solely upon himself. It will depend upon the work that he does as it is assigned to him, and the way he prepares himself for further responsibilities. No matter how far up the ladder he goes, he must always be preparing for the next rung higher up. The writer is no longer a young man and yet he finds that a great deal of time is spent in studying so that he will be more valuable in his present position. The reader too will have to take as his guiding star the thought that he must ever be preparing himself for the future.

That what has been said is true is well illustrated by a recent example as portrayed by one of our own graduates. For about a year and a half after graduation this man was enthusiastic about the work he was doing in his company. He was in the testing department and found that the work was interesting, as he was testing this machine and that device, and

[5] Works Manager, Chief Engineer, The Cincinnati Milling Machine Company, Cincinnati, Ohio. Fellow ASME.

[6] Head, Department of Machine Design, The Cooper Union, New York, N. Y. Mem. ASME.

he said there was always something different. Suddenly one day the writer received a communication from another company asking if he would write a recommendation for this same young man. The writer immediately telephoned him and asked what the trouble was; certainly his past conversations had indicated a very satisfactory attitude toward his work. Why this sudden change?

He complained about being stymied; he was doing the same job day after day. Yes, he was testing different pieces of machinery but he was reading the same gages and working on the same material. And his company didn't seem to be very enthusiastic about promoting him. There didn't seem to be much ahead. It looked as though he was going to be on testing for the rest of his life. It will be noted that these are exactly the same things that have been said about the man who feels disgruntled over the job on the drawing board.

From this we can see that there is no open road to rapid promotion. One must prove his worth and must also expect that it is going to take time; for some more than for others. Companies do not hire vice-presidents from college. They develop them in their organizations through long years of experience, and this is true no matter what position is the jumping-off place. The young graduate can be assured that if he goes into the design field because he likes creative work, he too can look forward to top positions in industry. But only if he has the will and puts forth the effort to obtain such positions. To the writer this is the most salient part of the paper that the author has presented.

AUTHOR'S CLOSURE

The author is deeply appreciative of the comments made by Messrs. Carmichael, Darling, Linn, Nenninger, and Young.

Their contributions add considerably to the paper, and many of their remarks could profitably be studied by young and even old engineers.

J. F. DOWNIE SMITH.[7]

[7] Dean of Engineering, Iowa State College, Ames, Iowa. Fellow ASME.

Orifice-Meter Installations

COMMENT BY L. K. SPINK[8]

The average agreement ratios listed in Table 2 of this paper[9] are consistent with results which are being obtained in the metering of natural gas where careful attention is paid to the requirements for good measurement. The author's task was somewhat more difficult because the fluid in the lead lines was not of negligible density and, therefore, required exact balancing.

He has covered his procedure quite thoroughly with one exception: Detailed description of the daily operation of zeroing the meters. No mention is made of equalizing the sealpots after zeroing. It is a fairly common belief that, because the shutoff valves at the meter are closed when the by-pass is opened and are not reopened until the by-pass is closed, no sealing liquid is transferred during this operation. Actually, sealing liquid is transferred from the high-pressure side of the manometer to the low-pressure chamber and locked in that portion of the system by the zeroing operation. Repeated operations will overflow the low-pressure seal pot, and this is often what occurs when meter users complain of seal-liquid leakage.

Except for differences in volumes transferred owing to difference in the operating differential when the zeroing was performed, this error would cancel in the two meters, but would contribute to greater differences between maximum and minimum agreement ratios and would cause the orifice-meter readings to be low.

It is not difficult to keep piping tight enough to hold liquid, and it is hard to believe that seal pots constructed with the care indicated in the "Description of the Dual Orifice-Meter Installations" would leak any appreciable amount of sealing liquid, as mentioned under "Selection of Data."

In any case, the paper is convincing proof of what can be accomplished with orifice meters, and, as such, is a valuable contribution to industry. We never cease to be amazed by the confidence with which many engineers will accept the reading of the dial on a displacement meter, or gagings on a tank of questionable dimensions, but will look with skepticism on the readings of the orifice meter. Therefore, it is refreshing to note the author's conclusion that orifice meters are more accurate than tank gaging. In this case, however, there is the possibility of canceling errors in the two meters of similar type which would cast doubt on the validity of the conclusion.

[8] Engineer in Charge of Flow Measurement, Foxboro Company, Foxboro, Mass. Mem. ASME.

[9] "Precision and Accuracy of Orifice-Meter Installations," by L. V. Cunningham, Jr., MECHANICAL ENGINEERING, vol. 72, December, 1950, pp. 979–983

COMMENT BY R. F. STEARNS[10]

Many persons who encounter flow-measurement problems in the course of their engineering work may question the accuracy of data not supported by a specific calibration. Thus, it may appear that inaccuracies must occur in orifice metering as a result of the numerous factors involved. That such is not the case is well illustrated by the foregoing paper.

Extensive study of orifice meters has developed standard installations and sufficient data so that calibration for varying applications is seldom necessary if installations conform to specifications. This understanding, although generally accepted, has not been strengthened previously by supporting data on accuracy experience with standard orifice meters in commercial use.

Although there are some data in the literature on the effects of deviations from the procedures established by the Fluid Meters Committee, the subject of accuracy seems to have been neglected. Because of the number of variables involved, it is often difficult to make more than a general estimate of the accuracy of orifice meters. It is of interest, however, that the average accuracy of the meters described in the paper falls within the probable over-all tolerance of ± 1.25 per cent indicated by the ASME Test Codes for measurements in carefully engineered and maintained installations.

In many cases, the meter location and the use made of its records will determine how high a degree of accuracy is required. If fluids are being transferred inside the limits of a particular company, consistency of operation may be more desirable for process-control purposes than a close approach to absolute accuracy. The performance of the dual orifice meters reported in the paper emphasizes the precision of meters that are properly installed and maintained.

On the other hand, it is evident that correctness of measurement is essential where meter records furnish the basis for buying and selling transactions between two parties. To avoid varying interpretations of these records, it is important for the buyer and the seller to agree on the following:

1 The construction, operation, and maintenance of meter installations.

2 The procedure followed in handling meter records.

3 The sources of physical data employed in calculating flow rates.

An appreciation of the degree of accuracy which may be expected must also be

[10] Esso Engineering Department, Standard Oil Development Company, Linden, N. J.

developed. The various associations of gas producers have achieved a notable uniformity in the handling of these matters.

In the transfer of liquids between two parties, tank gaging normally is considered the standard for measurements and preferable to orifice meters on an accuracy basis. The examples described in the paper illustrate what can be done with the latter in liquid-metering applications. It is important to note the following:

1 That good results were accomplished by close adherence to the ASME Standards (which may differentiate these installations from the average orifice meter).

2 That accurate tank gaging of the light liquid hydrocarbons would have involved special handling problems in this case.

It is of interest to mention that the study reported in the paper was originally undertaken for use in a book on orifice meters being prepared by the Standard Oil Development Company in co-operation with other affiliates of the Standard Oil Company (New Jersey). When considering subject material for a revised edition of a company handbook on the use of orifice meters, it was felt desirable to include readily available data on accuracy.[11]

The data given in the paper represent the analysis of normal records from standard orifice-meter installations. It is hoped that presentation of this material will focus attention on the need for more data on accuracy of metering to guide and improve commercial measurements. There is undoubtedly much information of this nature which has never been worked up for publication.

[11] This book will be published in 1951 for sale to the general public under the title of "Flow Measurement with Orifice Meters."

Comment on Current Papers

TO THE EDITOR:

The December, 1950, issue of MECHANICAL ENGINEERING contains several articles of considerable interest to the writer.

In the "Comments on Papers," I note, in the author's closure of the paper "Cam-Follower Systems" (page 1009), that the cycloid cam is not necessarily the optimum shape. In suggesting that it might be, I was considering the ideal case of a cam simply moving a mass under the action of inertia forces only. When elasticity, damping, and possibly other resistances are added, the optimum shape might involve an extremely complicated problem.

The case of a harmonic cam with no dwell is essentially the case of a slider driven by a crank and connecting rod. In this case the acceleration at the end of the stroke has built up gradually from zero at about the middle of the stroke, and I find the maximum acceleration of the cycloid cam to be just twice that of the harmonic cam. Here, however, the real disadvantage of the harmonic cam—almost instantaneous acceleration from a position of rest (not passing through zero velocity)—is absent.

It is encouraging to note the sustained interest which is shown in machine design, by the appearance of the paper, "Machine Design as a Career," following Professor Hartman's paper on the same subject in May, 1949. In both cases considerable emphasis is laid on the reluctance of graduate engineers to work on the drawing board. I have commented on this before (MECHANICAL ENGINEERING, October, 1949), but Dr. Downie Smith's example of a college and a noncollege man working side by side reminds me that, in the past at all events, the chief draftsman or chief designer was frequently an extremely practical man with considerable executive ability, but often very resistant to anything in the way of a theoretical approach to the design problems, and lacking in knowledge of engineering principles.

In the preface to his "Civil Engineer's Pocket Book," Trautwine says:

> "It is ignorance of these principles . . . . that constitutes what is popularly called the Practical Engineer. . . . . . . who blunders along, without knowing any reason for what he does, than that he has seen it done so before. And it is this same ignorance that causes employers to prefer this practical man to one who is conversant with principles. They themselves cannot master leverage, equality of moments, and virtual velocities . . . . . and they naturally set down any man as a fool who can."

Undoubtedly, there has been vast improvement in men and methods since Trautwine wrote this, but some such conditions still linger on here and there in drafting rooms. Graduate engineers often suspect this, and are reluctant to encounter them, though they are naturally unwilling to say so to a prospective employer.

Dr. Downie Smith has presented the whole situation of machine design with great knowledge and insight. I am sure, from my own experience, that he is right in saying, or at least implying, that the only men who are "on the board for life" are those who are inventive and practical, but without technical knowledge or executive powers. After all, a great deal depends on what a man wants to do; there is such a thing as advancement being purchased at the price of doing work that is a burden instead of an absorbing interest.

The paper on "The Engineer's Stake in Public Relations," has been given my close attention. I have never been much in favor of "selling" the engineering profession to the lay public, largely because it is difficult to see how this can be done in a significant way. Also, is the author right in the statement that the lay mind has any better understanding of the work of doctors and lawyers than it has of that of engineers? Of course the public knows that doctors treat the sick, and lawyers deal with legal relationships, which is another way of saying that doctors practice medicine and lawyers practice law. Is it not, however, equally apparent that engineers build bridges, erect dams, and construct machines—in other words, practice engineering? The public comes into professional contact with doctors and lawyers—sees prescriptions written and possibly law books consulted, which may give an illusory sense of knowing what they do, but essentially can they understand how a doctor and a lawyer get their results any better than they understand how an engineer gets his? I question it.

Then again (see paragraph "Obscurity of the Engineer"), people are undoubtedly more familiar with the names of present-day generals, statesmen, poets, and actors than they are with those of contemporary engineers. May this not be due, largely, to modern engineering work being carried out by a number of engineers in a firm, with whose name the work is associated? The public is certainly familiar enough with the names of the great engineering corporations, but can hardly be expected to know their personnel. Going back to the past, I feel sure that the names of Watt, Stephenson, and Fulton (whose name is borne by a street in New York, and whose birthplace, Little Britain in Lancaster County, Pa., was renamed for him) would be as likely to occur to a reasonably well-informed person as would those of Wellington, Grant, Lee, Pitt, Keats, Longfellow, the Kembles, or Lavoisier.

In considering the Hollywood picture of engineers, it must be remembered that,

in presenting any profession or way of life on the screen, something emphasizing vividly the outward and visible signs must be shown to be recognized by a lay audience. To a member of the particular profession, familiar with the background which the appearance on the screen calls up, it may seem false and exaggerated to the last degree. When I see an engineer portrayed in the movies, he seems like a caricature. But I have been told by a surgical friend of mine that when he sees an operation performed on the screen, he gets the same sort of reaction which I do to an engineer, though the surgeon (or anything but an engineer) seems as natural to me as the engineer (or anything but a surgeon) seems to him. It would appear from this that a nonprofessional layman would have about as good an idea of any one profession as he would of any other. It would also appear that a member of any particular profession, himself being a layman to all the others, could only detect the false image of his own profession in the lay mind.

Poe makes use of a very similar idea in his "Murders in the Rue Morgue," where a number of men of different nationalities overhear the murderer's voice. Each one is convinced that he is listening to one of the others' languages, though what they all hear turns out to be the chattering of an ape. Poe was very accurate and logical in his mystery stories; I was once told by a high-grade detective that the method of searching described in "The Purloined Letter" was in accord with modern practice in looking for evidence.

Under "Scientists Widely Recognized," it is stated that scientists have done a superb job in dramatizing their profession. No doubt some good books have appeared, which give a good general outline of the work of scientists, but this dramatization has also resulted in a flood of pseudoscientific reading matter, which has bred some strange misconceptions of scientific work in the lay mind. Anyone who doubts this might read "Science Is a Sacred Cow" (Anthony Standen, E. P. Dutton & Company Inc., New York, N.Y.). No doubt engineers could do the same thing equally well, but, before doing it, some thought might be given to the danger of getting the same sort of result with engineering.

CYRIL O. RHYS.[12]

[12] Mechanical Engineer, Standard Development Company, Elizabeth, N. J. Mem. ASME.

The Engineer in Public Relations

TO THE EDITOR:

John D. Waugh in "The Engineer's Stake in Public Relations" (MECHANICAL ENGINEERING, December, 1950, pages 984–986) does not mention one important reason for the failure of engineers to get full public recognition. I refer to the censorship in engineering societies on economic implications of engineering developments.

A group of doctors may carry on research in the use of a drug or method in curing a disease. Their conclusions may be only partly valid, but they seem to have little difficulty in presenting them before some medical-society meeting or in a medical journal. Newspapers publish such conclusions because of the many readers who are sure to be interested. The medical profession thereby gets a reputation of trying to serve the public even if further research modifies the reported conclusions.

Lawyers discuss in various public forums all sorts of problems from graft in public administration to the weaknesses in opinions of the U. S. Supreme Court. They do so knowing that many of their professional brothers will not agree with their conclusions. And by so doing, the legal profession gets a reputation for advancing the public welfare.

The engineer has difficulty in getting such opportunities in behalf of public welfare. He cannot go to the newspapers direct as they are engaged in reporting events and not in propaganda for an idea or project. The editor will refer the author of a paper on the economic applications of an engineering development to the professional society. The professional society will inform the author that its interest is in basic engineering, not in economic applications of engineering knowledge. If the professional engineering societies would publish such economic-engineering papers and give them publicity, the newspapers would summarize them as they do for the opinions of doctors and lawyers. And the public's recognition of the engineering profession would be advanced.

The American Society of Civil Engineers published some years ago a symposium on the costs and benefits of waterway transportation in competition with railroad transportation. That step was in the direction of getting recognition for civil engineers.

The American Institute of Mining and Metallurgical Engineers published a paper on "Municipal-Water Needs Vs. Strip Coal Mining." It was a criticism of methods and results in a lawsuit in Pennsylvania where contamination of a public water supply by acid mine water was involved. The Institute's publication committee at first turned the paper down. The Institute's willingness when requested to give the reasons for the turndown and the author's willingness to make what were in his opinion minor changes made possible the publication of a paper of about 20 pages. The paper has apparently been more valuable to public-health authorities than to coal-mining companies judging by requests the author has received for reprints. Its publication, however, was a step in the direction of getting public recognition for engineers trying to serve the public welfare.

The policy of The American Society of Mechanical Engineers may have been revised since my unfortunate experience with it several years ago. I presented a paper on a study of electrical rates in a suburban community. All sorts of reasons were given why the paper should not be presented although after much travail it was presented. A more liberal attitude is needed by the Society as to such papers if it is to advance public recognition of engineers. Why censor a member's ideas? Let those who do not like them talk back in a public debate! And the newspapers will give the debate publicity as they do the ideas of doctors and lawyers even when there is disagreement in their professions.

The Society has recently published data on heat pumps. Such data would have more meaning to the public if tied down to a specific community with estimates of capital and operating costs, possible savings in coal and gas bills, comparative costs of equipment needed for the usual fuels and for a heat pump for houses of various sizes. If given publicity, such a paper would be summarized by newspapers in the community affected. The public would have an illustration of what engineers are seeking to do for them. Using the regional branches of the Society, the paper would have publicity in a large number of communities. Public recognition for engineers would be advanced.

The trouble is that too many of the Society's committees are filled with employees of public utilities, coal companies, and boiler manufacturers whose financial interests would be adversely affected by the increased use of heat pumps. And so the public will not learn about heat pumps as soon as it should and engineers will continue to be men without the recognition they deserve.

GREGORY M. DEXTER.[13]

[13] Scarsdale, N. Y. Mem. ASME.

The Present Shortage of Engineers

TO THE EDITOR:

The present shortage of engineers would not be remedied by the large increase in engineering-school enrollment which has been advocated. As always, only those who have the necessary talent and aptitude should be encouraged to pursue an engineering career. It is generally agreed that at least six years are required to develop a responsible engineer. This should include a regular four-year course and two years of graduate work or a somewhat longer training period in industry. Thus today's needs will not be met by starting more men and women in engineering courses.

As recently as a year ago surveys of the engineering field indicated that it was attracting too many of our college students. Now the current status of the nation's rearming has made it superficially appear otherwise. However, as the defense program becomes further developed the emphasis is likely to be on the need for other manpower.

Much more immediate action can be taken to expedite the engineering required for rearmament. It is suggested that engineers could co-operate, as long as the present situation exists, by sponsorship of the following:

(*a*) *The more efficient use of engineering ability.* It is the fashion to consider a successful engineer as one who spends most of his time on office administration, employee relations, customer relations, or other work which could be done by nontechnical personnel. This is unprofessional. We should regard as our foremost task the employment of our knowledge of applied science.

(*b*) *The wide use of other scientists.* Leading physical scientists are already fully employed but there should still be available persons who have studied mathematics, physics, or chemistry.

(*c*) *The training of technicians in limited fields.* This could be accomplished quickly and would relieve the present burden on many engineering staffs.

C. S. L. ROBINSON.[14]

Huey Gas Turbine

COMMENT BY DAVID ARONSON[15]

The paper[16] describes the use of generator air coolers for the purpose of cooling the air before it enters the compressor. How does such an installation compare in terms of cost and performance with an adiabatic humidifier, which in a dry climate can cool the air effectively?

AUTHOR'S CLOSURE

In answer to Mr. Aronson's question regarding the performance of an adiabatic humidifier as compared to the surface-type cooler provided—while we have well water at around 60 F for this purpose, in an especially dry climate, it would appear that the air washer might probably provide lower temperatures and should have somewhat cheaper installation cost than a surface cooler if this equipment was purchased new. However, we would prefer the surface cooler as installed rather than to hazard dirt and scale which would accumulate on the compressor blades and probably result in damage and subsequent loss of capacity.

C. C. WILLIS.[17]

[14] West Newton, Mass. Mem. ASME.

[15] Research and Development Department, Elliott Company, Jeannette, Pa. Mem. ASME.

[16] "The Huey Gas Turbine—Engineering and Construction Problems Involved in Installation," by C. C. Willis and E. C. Goldsworth, MECHANICAL ENGINEERING, vol. 72, November, 1950, pp. 881–885.

Gas-Turbine Developments

COMMENT BY T. C. RATHBONE[18]

The insurance carriers naturally have been following gas-turbine developments, such as described in this paper,[19] with keen interest. Underwriting experience on gas turbines and axial-flow compressors prior to this Belle Isle installation largely had been confined to those used in the oil industry supplying air in the Houdry process, where inlet temperatures are generally within limits already common in steam-turbine practice.

Gas-turbine units for power generation, with their increasing sizes, higher temperatures, and intimately associated and connected components present a new problem for the insurers. The life of aircraft turbines operating at comparable temperatures is measured in terms of hours, while turbine life for utility power must be reckoned in years.

Although the experience on this first utility installation covers something over thirteen months, its performance over this period of service, as so ably reported in the paper, is very reassuring. There were only two forced outages; both occasioned by failure of more or less standard auxiliary equipment, and not to any fault in the gas turbine or compressor components themselves. This is indeed a creditable record.

AUTHOR'S CLOSURE

The discussion by Mr. Rathbone is greatly appreciated and should be considered a valuable addition to the paper. The author believes credit should be given to Mr. Rathbone for his keen and correct analysis together with his accurate foresight. This statement is made since Mr. Rathbone inspected this unit while it was still in the manufacturer's plant undergoing tests. At that time, the insurance companies had no rating established for such equipment, and Mr. Rathbone was detailed to check into the unit and make recommendations which would allow the establishment of an insurance rate.

It should be of interest to note that the present rating established for this type of unit is virtually the same as is applied to a steam unit of like rating. Our operating experience certainly indicates that units of this type can be expected to have the same availability as modern steam units; hence the placing of the gas-turbine insurance coverage in the same class as steam-turbine coverage would seem correct.

J. W. BLAKE.[20]

[17] Superintendent of Generation, Oklahoma Gas and Electric Company, Oklahoma City, Okla. Mem. ASME.

[18] Chief Engineer, Fidelity & Casualty Company of New York, New York, N. Y. Mem. ASME.

[19] "Combination Gas Turbine—Steam Turbine Unit," by J. W. Blake, MECHANICAL ENGINEERING, vol. 73, January, 1951, pp. 14–16.

[20] Assistant Superintendent of Generation, Oklahoma Gas and Electric Company, Oklahoma City, Okla.

Books Received in Library

DAVISON'S TEXTILE BLUE BOOK, 85th Year, July, 1950, Handy edition. Davison Publishing Company, Ridgewood, N. J. Fabrikoid, 5 × 8 in., 1415 pp., illus., maps, tables, handy edition (without classified directory and buyer's guide) $5.75. Office edition (with classified directory and buyer's guide), $8.25. This standard directory contains condensed information concerning mills of the textile industry, covering cotton, woolen, rayon, silk and jute goods, and those using the processes of knitting, dyeing, sanforization, and so on. Related activities covered include listings of brokers, exporters, foreign firms, trade associations, testing laboratories, textile schools, and railroads serving the trade.

ENGINEERING PROFESSION. By T. J. Hoover and J. C. L. Fish. Second edition. Stanford University Press, Stanford, Calif.; Geoffrey Cumberlege, Oxford University Press, London, England, 1950. Fabrikoid, 6¼ × 9¼ in., 486 pp., diagrams, charts, tables, maps, $7.50. ENGINEERING METHOD. By J. C. L. Fish. Stanford University Press, Stanford, Calif., 1950. Linen, 6 × 9¼ in., 186 pp., diagrams, charts, tables, $3. Serving both as a vocational guide and an analysis of the profession, this book describes the qualifications and duties of the professional engineer and his habit of mind. Following the discussion of who is an engineer, what is engineering, and the general scope of engineering, the next five

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

chapters discuss specific types of engineering. The method of engineering is considered next, and then three chapters deal with vocational guidance, education, and the contribution of engineers to mankind. Chapters 9, 10, and 11 have been organized in a separate volume entitled "The Engineering Method."

FLOW MEASUREMENT WITH ORIFICE METERS. By R. F. Stearns, R. M. Jackson, R. R. Johnson, and C. A. Larson. D. Van Nostrand Co., Inc., Toronto, Canada; New York, N. Y.; London, England, 1951. Cloth, 7 × 10¼ in., 350 pp., illus., diagrams, charts, tables, $7.50. This book is intended mainly for the use of engineering, technical service, and instrument groups concerned with process control, test work, and plant start-ups in the petroleum industry. It provides all the information required for the effective use of fixed-area orifice meters in common refinery applications. The procedures outlined typify methods currently used in refinery operations, and the extensive physical data presented are limited for the most part to fluids found in petroleum refining.

FUELS AND COMBUSTION HANDBOOK. Edited by A. J. Johnson and G. H. Auth. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Cloth, 6 × 9¼ in., 915 pp., diagrams, charts, maps, tables, $12.50. This comprehensive reference work is devoted to the properties, uses, and combustion of solid, liquid, and gaseous fuels. The basic types of combustion of these fuels and operation and use of combustion equipment are dealt with. Comparative tables showing characteristics of optional equipment are given. The use of alignment charts, tables, and graphs provides quick solutions to problems in the selection and use of fuels. A wide range of topics is covered including synthetic fuels, smoke prevention, fuel handling and storing, chimney design, the heat pump, and miscellaneous sources of heat and power.

GUILLET'S KINEMATICS OF MACHINES. By A. H. Church. Fifth edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1950. Linen, 5½ × 8¾ in. 299 pp., illus., diagrams, charts, tables, $4. The fifth edition of this standard work continues the emphasis on practical applications embodied in previous editions. The most noteworthy changes are revision of the chapter on velocity and acceleration in plane motion, addition of an article on Coriolis' acceleration, revamping of the section on gearing, addition of the tabulation method for locating instant centers, a revision of the proof of Klein's construction, and the inversions of the slider crank mechanism.

INDUSTRIAL AND SAFETY PROBLEMS OF NUCLEAR TECHNOLOGY. Edited by M. H. Shamos and S. G. Roth. Harper & Brothers, Inc., New York, N, Y., 1950. Linen, 5½ × 8¼ in., 368 pp., illus., diagrams, charts, tables, $4. Based on papers presented at a recent conference held at New York University, this book is devoted to problems of the use of atomic energy. Part 1 considers details of the organization and operation of the United States Atomic Energy Commission. The fundamentals of nuclear physics, nuclear apparatus, the radio-chemical laboratory, and industrial applications of radioactive isotopes are discussed in Parts 2 and 3. Part IV deals with possible health hazards associated with the use of radioactive materials. References are given at the end of some of the chapters.

INDUSTRIAL SOLVENTS. By I. Mellan. Second edition. Reinhold Publishing Corporation, Book Division, New York, N. Y., 1950. Linen, 6 × 9¼ in., 758 pp., illus., diagrams, charts, tables, $12. An organized compilation of the literature on the more important industrial solvents. This edition retains the original organization with only minor changes in format. It includes many recently developed solvents and uses. The chapters on plasticizers and on graphic expression and interpretation are eliminated. A new chapter on safe handling of solvents is added, and selected bibliographies are included.

INGENIOUS MECHANISMS FOR DESIGNERS AND INVENTORS, VOLUME 3. Edited by H. L. Horton. Industrial Press, New York, N. Y., 1951. Fabrikoid, 6 × 9¼ in., 536 pp., diagrams, $6. A companion to Volumes 1 and 2 of this series, this self-contained reference work is a part of a set which forms a comprehensive encyclopedia of mechanical movements. It contains illustrated descriptions of a large variety of standard and special mechanisms for use in designing automatic machines and other mechanical devices. Mechanisms of the same general type are grouped in chapters comparable with the arrangement in the previous volume.

INTRODUCTION TO MECHANICAL DESIGN. By T. B. Jefferson and W. J. Brooking. Ronald Press Co., New York, N. Y., 1951. Linen, 6 × 9¼ in., 612 pp., illus., diagrams, charts, tables, $6.50. This textbook approaches the subject as a whole in the light of the functional purposes of a machine, its configuration requirements, economic considerations, the use of rational and empirical design data, and desired final appearance. Against this background is presented the elementary theory of machine elements including a number of design considerations not usually covered in machine-design texts. Although courses in the mechanics of materials and in the calculus are desirable prerequisites, they are not necessities.

MATHEMATICAL ENGINEERING ANALYSIS. By R. Oldenburger. The Macmillan Co., New York, N. Y., 1950. Cloth, 6¼ × 9½ in., 426 pp., illus., diagrams, charts, tables, $6. Intended for use as a text in courses on engineering analysis and industrial physics, this book is written to aid those who need to express physical situations in the form of equivalent mathematical relations. It develops the basic laws of engineering from a minimum number of assumptions so that the reader can obtain a logical physical and mathematical picture of the fundamental concepts of engineering in common use. With this as a background, the various techniques for making simplifying assumptions in treating physical problems are then illustrated. A knowledge of advanced calculus, especially those aspects concerned with line, surface, and volume integrals, is assumed.

MOTION AND TIME STUDY, Principles and Practice. By M. E. Mundel. Prentice-Hall, Inc.; New York, N. Y., 1950. Linen, 6 × 9¼ in., 457 pp., illus., diagrams, charts, tables, $6.65. This book is intended to provide a systematic, practical, and scientifically correct treatment of present-day motion and time study. It considers the development and application of the basic principles of successful work. Illustrative examples from a wide variety of industries and types of work demonstrate the highly important reasoning process involved in the application of procedures. Graphic analyses are presented in the form in which they would normally appear in practice so as to provide a working guide.

NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS, Proceedings, Volume III, October 26–27, 1949; published by National Conference on Industrial Hydraulics, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill., 1950. Paper, 6 × 9 in., 218 pp., illus., diagrams, charts, maps, tables, $3.50. This volume contains the papers presented at the 1949 Conference. Broadly classified, the first papers deal with recent developments in the field, followed by papers on hydraulic components, pumps and turbines, technical design data, equipment standards, and applications and performance. A special paper deals with atomic power and aricraft propulsion.

ORDINARY NON-LINEAR DIFFERENTIAL EQUATIONS IN ENGINEERING AND PHYSICAL SCIENCES. By N. W. McLachlan. Oxford University Press, New York, N. Y.; Clarendon Press, Oxford, England, 1950. Cloth, 6 × 9½ in., 201 pp., diagrams, charts, tables, $4.25. This book shows how certain types of nonlinear problems may be solved, and how experimental results may be interpreted by nonlinear analysis. It is chiefly confined to the presentation of various analytical methods employed in the solution of important technical problems. A wide variety of these are included, and practical details are given. References are given to sources of more rigorous theoretical treatments of the methods used.

PRESSWORKING OF METALS. By C. W. Hinman. Second edition. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, 6 × 9¼ in., 551 pp., illus., diagrams, charts, tables, $8.50. A reference book which illustrates and describes a wide variety of press tool designs, press types, and accessories, including examples of their practical use. In the second edition, a large number of new designs, more explanations on how presses are designed to operate with different types of dies, more reference tables, and more mathematical formulas are included. Special attention is given to design of progressive dies and machines.

PRODUCTIVITY IN THE BLAST-FURNACE AND OPEN-HEARTH SEGMENTS OF THE STEEL INDUSTRY: 1920–1946. By W. T. Hogan. Fordham University Press, The Declan X. McMullen Company, Distributors, New York, N. Y., 1950. Linen, 6 × 9¼ in., 150 pp., illus., diagrams, charts, tables, $4. An economic analysis of changes in productivity from 1920–1946 in two important divisions of the steel industry. Following a general discussion of productivity, the technological improvements, metallurgical developments, organizational and engineering techniques, and labor efficiency in both the blast-furnace and open-hearth plants and processes are discussed. A bibliography is also included.

PROGRESS IN COAL SCIENCE. Edited by D. H. Bangham. Interscience Publishers, New York,

N. Y.; Butterworths Scientific Publications, London, England, 1950. Linen, 6 × 10 in., 456 pp., illus., diagrams, charts, tables, $7. Containing a selection of reports published previously in the Monthly Bulletin of the British Coal Utilization Research Association, this book is intended to provide information on aspects of coal technology and utilization which are inadequately covered by existing textbooks. The papers are grouped in five sections: modern experimental techniques; fine particles and grinding; constituents of coal; organic chemistry of coal products; and chemical aspects of combustion and gasification. Extensive reference lists accompany each paper.

PRÜFUNGS- UND ÜBUNGSAUFGABEN AUS DER MECHANIK DES PUNKTES UND DES STARREN KÖRPERS. Teil I—Statik. By K. Federhofer. Springer-Verlag, Vienna, Austria, 1950. Paper 6 × 9 in., 130 pp., diagrams, $2.30. The first volume in a projected series of three, this textbook contains problems and their solutions on various aspects of the analysis of linkages and rigid bodies. The fields of analytical and graphical statics are covered with the exception of stress and dimensional change considerations. For the difficult problems, explanations of the procedures used accompany the solutions. Succeeding volumes are to deal with kinematics and kinetics.

QUANTUM MECHANICS. By A. Landé. Pitman Publishing Corporation, New York, N. Y.; Toronto, Canada; London, England, 1951. Linen, 6 × 9¹/₄ in., 307 pp., diagrams, charts, tables, $5.50. This book serves as an introduction to the subject and emphasizes the physical background of quantum mechanics and its close relation to classical experience. The principles of quantum mechanics are derived from a critical analysis of a few standard experiments. In a similar inductive manner, the technique of matrix mechanics is developed. Considerable space is devoted to nonconservative processes, and the Dirac electron and the elementary theory of radiation are considered. The last chapter deals with mesons. A bibliography of standard works is included.

RADIATION MONITORING IN ATOMIC DEFENSE. By D. E. Gray and J. H. Martens. D. Van Nostrand Company, Inc., Toronto, Canada; New York, N. Y.; London, England, 1951. Linen, 5¹/₂ × 8 in., 122 pp., illus., diagrams, charts, $2. This practical working manual for radiological defense personnel provides full details on the use of all standard radiation detectors and the interpretation of their results. Brief background information is given on atomic energy, on radiation hazards, and on protective measures against atomic explosions. The book is intended for anyone concerned with the measurement of radiation and requires no technical background to understand or use it.

REGELTECHNIK. By K. Seidl. Franz Deuticke, Vienna, Austria, 1950. Paper, 6¹/₈ × 9³/₄ in., 68 pp., diagrams, charts, tables, $1.70. This book explains the principles of various types of automatic control equipment as used in power stations; conveyer systems; automatic drives for cars, ships, and airplanes; control of gas pressure and flow, etc. It covers fundamentals and theory of control and regulating equipment, the characteristics of different types of control mechanisms and circuits, and the underlying mathematical principles.

RICHTLINIEN FÜR DIE AUFBEREITUNG VON KESSELSPEISEWASSER UND KÜHLWASSER. Edited by Vereinigung der Grosskesselbesitzer. Fourth edition. Vulkan-Verlag, Dr. W. Classen, Essen, Germany, 1950. Cloth, 5³/₄ × 8¹/₄ in., 304 pp., illus., diagrams, charts, tables, 20 Dm. This book is devoted to rules for construction of various types of installations used for treating either large or small quantities of boiler feedwater. Procedures for analysis of water are considered as well as mathematical procedures and tables used for determination of feedwater characteristics. The properties of the various chemicals used in water treatment are also discussed.

STATISTICAL ABSTRACT OF THE UNITED STATES. Seventy-first edition, 1950. Published by U. S. Department of Commerce, Bureau of the Census; for sale by Supt. of Documents, Government Printing Office, Washington 25, D. C. Cloth, 6 × 9¹/₄ in., 1040 pp., charts, tables, $3. Important summary statistics are presented on the industrial, social, political, and economic organization of the United States compiled from reports of the various Federal bureaus and agencies. In this 1950 edition, a new section entitled "Business Enterprise" depicts, in general, the place and behavior of the business firm and business initiative in the American economy. Tables on Federal courts stressing their civil activities are new, as well as tables on output per man-hour, labor-union membership, the nation's economic budget, and on activities of the Soil Conservation Service and the Commodity Credit Corporation.

STEAM AND GAS TURBINES. By B. G. A. Skrotzki and W. A. Vopat. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada, and London, England, 1950. Cloth, 395 pp., illus., diagrams, charts, tables, $5. An expansion of material originally published as special sections in *Power*, this book is of particular interest to operating engineers in the power field. It describes the general arrangement and assembly, the operating principles, the performance limitations, and the auxiliary and control devices needed for the operation and maintenance of both prime-mover types. Reheat steam turbines, automatic-extraction turbines, small-output gas turbines, regenerative-cycle units, and power-gas generators are among the types discussed. Oiling systems of all turbine types are covered in detail.

SYMPOSIUM ON METALLURGICAL ASPECTS OF NON-FERROUS METAL MELTING AND CASTING OF INGOTS FOR WORKING. (Institute of Metals Monograph and Report Series, No. 6.) Institute of Metals, London, England, 1949. Linen, 5¹/₂ × 8³/₄ in., 168 pp., illus., diagrams, charts, tables, 15s, or $2.50. This book contains six papers, with discussions, on the subject of ingot casting, from both the practical and theoretical aspects. The melting and casting of non-ferrous metals, the production of refined-copper shapes, the melting and casting of aluminium-bronze ingots, the application of flux degassing to commercially cast phosphor bronze, the melting and casting of brass, and the melting and casting of nickel silver are the topics covered.

SYMPOSIUM ON PLASTICITY AND CREEP OF METALS, presented at ASTM National Meeting, San Francisco, California, October 10, 1949. (Special Technical Publication No. 107.) American Society for Testing Materials, Philadelphia 3, Pa., 1950. Paper, 6 × 9 in., 68 pp., illus., diagrams, charts, tables, $1.50. Presented at the First Pacific Area National Meeting of the Society in 1949, the four papers in this symposium deal, respectively, with an experimental exploration of plastic flow in sheet metals, a consideration of forming parameters and criteria for design and production, a discussion of the use of creep data in design, and a review of super-creep-resistant alloys.

TECHNOLOGICAL APPLICATIONS OF STATISTICS. (Wiley Publications in Statistics). By L. H. C. Tippett. John Wiley & Sons, Inc., New York N. Y.; Williams & Norgate, Ltd., London, England, 1950 Linen, 6 × 9¹/₄ in., 189 pp., diagrams, charts, tables, $3.50. Based on a series of lectures delivered at the Massachusetts Institute of Technology, this book is an introduction to statistical methods applied to technological problems. Part I deals with routine control of quality and covers measurement of quality, various aspects of control charts, and acceptance sampling. Part II treats topics of investigation and experimentation and provides information on the statistical theory of errors, applications of the analysis of variance and of correlation analysis, and the planning of an investigation. The practical importance of the mathematical assumptions involved is stressed throughout.

TEXTILE FIBERS. By L. E. Parsons and J. K. Stearns. International Textbook Company, Scranton, Pa., 1951. Linen, 5¹/₂ × 8¹/₄ in., paged in sections, illus., diagrams, charts, maps, tables, $4. A handy reference for the textile merchant, the chemist, the technologist, the manufacturer, and the student, this book provides a practical guide to the raw materials and yarns used to produce today's fabrics. Divided into four independent parts, it contains a detailed treatment of cotton, wool, man-made fibers, and yarns. A series of questions is given at the end of each part.

(THE) THEORY OF VIBRATIONS FOR ENGINEERS. By E. B. Cole. Second edition. Crosby Lockwood & Son, Ltd., London, England, 1950. Linen, 5¹/₂ × 8³/₄ in., 334 pp., illus., diagrams, charts, tables, 18s. This book bridges the gap between an elementary treatment and the important analyses needed in the correction and elimination of vibrations. This second edition is enlarged and almost completely rewritten. Vector methods are used in the solution of problems, and many new examples are added. Only the most elementary knowledge of the calculus is assumed as a full explanation of all advanced mathematical processes is given.

TREATISE ON POWDER METALLURGY, Volume II. Applied and Physical Powder Metallurgy. By C. G. Goetzel. Interscience Publishers, New York, N. Y., and London, England, 1950. Linen, 6 × 9¹/₄ in., 910 pp., illus., diagrams, charts, tables, $18. This second volume of a comprehensive three-volume work deals with (1) applied and (2) physical powder metallurgy. Part one, covering industrial materials and products in which powdered-metal parts are used, includes refractory metals and alloys, carbides and composition products, electrical and magnetic materials, and ferrous and nonferrous materials for structural parts. Part two is devoted to practical evaluations and theoretical analyses of the materials, products, and processes. The historical development of the theories of bonding and sintering is presented in detail, and the future of powder metallurgy is briefly considered.

DIE VORKALKULATION IN DER STANZEREI-TECHNIK. By H. L. Hilbert. Carl Henser Verlag, Munich, Germany, 1950. Cloth, 5³/₄ × 8¹/₂ in., 366 pp., diagrams, charts, tables, 32 Dm. This book serves the die-stamping and forming industry as a guide to the calculation of stamping operations. It is limited to a consideration of steel sheets of light and medium gage. However, many of

the calculations may be applied to heavy sheets and to light metals by making the necessary allowances. Economic considerations, the planning and layout of stamping operations, and scrap losses are discussed. Extensive design data in tabular form are given in an extensive appendix.

DIE ZWEISEITIG GELAGERTE PLATTE, Band I. Biegemomente und Durchbiegungen. By H. Olsen and F. Reinitzhuber. Second edition. Verlag von Wilhelm Ernst & Sohn, Berlin, Germany, 1950. Paper, $7^1/_4 \times 10^1/_2$ in., 113 pp., diagrams, charts, tables, 16 Dm., for sale by European Periodicals Publicity and Advertising Co., Ltd., London, England. This first volume of a two-volume set dealing with plates supported on two sides considers the basic principles and the calculation of bending moments and flexures. It presents a method by which it is possible to evaluate these plates with the greatest economical advantage. The method uses numerous diagrams which evaluate various loading conditions and the effects of moments and other mechanical quantities.

ASME BOILER CODE

Proposed Revisions and Addenda to Boiler Construction Code

As need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code. Simple changes are indicated directly. In the more involved revisions added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets [ ]. Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers 1949

PAR. P-299. Revise second paragraph to read:

Flanges made of other material permitted under the Code shall be equal at least to the strength requirements, and the facing dimensions and bolt circles shall agree with the American Standard otherwise required. Hub type flanges shall not be cut from plate material.

Unfired Pressure Vessels 1949

Table UA-8(b). In the 1b spaces of Columns I and II, insert semicolons between the terms, making them read:

$$\frac{W+T}{2}; \quad \left(\frac{W+N}{4}\max\right)$$

Unfired Pressure Vessels 1950

Par. UG-25(d). Add "(See Par. UW-52 (b))."

Table UA-47.2. In the 1b spaces of Columns I and II, insert semicolons between the terms, making them read:

$$\frac{W+T}{2}; \quad \left(\frac{W+N}{4}\max\right)$$

Par. UG-80(c). In fifth line, change "diameter" to "diameters."

Par. UG-101(c). Delete and substitute:

(c) The pressure part shall not have been subject to a pressure greater than twice the designed maximum working pressure, adjusted for operating temperature as described in Par. UG-99(b), prior to making the proof hydrostatic test.

PAR. UW-40(d). In fifth line, insert a hyphen between "stress" and "relieved."

PAR. UW-48(c). In first line, change "vessels" to "vessel."

PAR. UA-189. In seventh line, change "UG-22(b)" to "UG-22(6)."

PAR. UA-202(d). Delete and substitute:

(d) The pressure part shall not have been subject to a pressure greater than twice the designed maximum working pressure, adjusted for operating temperature as described in Par. UG-99(b), prior to making the proof hydrostatic test.

PAR. UA-280. Below Fig. UA-280.2, in the first line under "Unit Stresses," change "0.050" to "0.50." Below Fig. UA-280.5, in the formula for t_n, change "14150" to "15000" and "0.153" to "0.145."

Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code.

These cases pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

The following Case Interpretation was formulated at the Committee meeting December 15, 1950, and approved by the Board February 8, 1951.

CASE No. 1056 (REOPENED)

(Special Ruling)

Inquiry: May Pars. U-69 and U-201 vessels with maximum thickness of 0.58 in. be fabricated from flange quality steel meeting the following chemical and physical requirements?

Carbon, max per cent	0.33
Manganese, per cent	0.85–1.15
Phosphorus, max per cent	0.04
Sulphur, max per cent	0.05
Silicon, max per cent	0.10

	Grade A	Grade B
	$^3/_{16}$ to $^3/_8$ in.	Over $^3/_8$ to $^5/_8$ in.
Tensile strength, psi	75,000–90,000	73,000–88,000
Yield point, min psi	37,500	36,500
Elongation in 8 in., min per cent	$\frac{1,600,000}{\text{tens. str.}}$	$\frac{1,600,000}{\text{tens. str.}}$
Elongation in 2 in., min per cent	24.0	24.0

In all other respects the material shall comply with Specification SA-225 Grade B. Under Par. U-69 the maximum allowable design stress for metal temperatures not exceeding 650 F shall be 15,000 psi for Grade A, and 14,600 psi for Grade B, and under Par. U-201 the maximum allowable design stress for these same temperatures shall be 18,750 psi for Grade A and 18,250 psi for Grade B.

Reply: It is the opinion of the Committee that this material may be used within the limitations given in the inquiry in the fabrication of Pars. U-69 and U-201 vessels, except that stress-relieving is not required.

THE ENGINEERING PROFESSION

News and Notes

AS COMPILED AND EDITED BY A. F. BOCHENEK

Carey H. Brown Elected Chairman of EJC Engineering Manpower Commission

AT a meeting of the Engineering Manpower Commission of the Engineers Joint Council held at the Engineering Societies Building on March 27, 1951, Carey H. Brown, Mem. ASME, of the Eastman Kodak Company, Rochester, N. Y., was elected chairman to succeed E. G. Bailey, past-president ASME, who has been acting as temporary chairman since the organization of the Commission. Thomas A. Marshall, Jr., Mem. ASME, of New York, was elected executive secretary of the Commission. He will devote full time to this post.

Colonel Brown, general superintendent, Service Department, Kodak Park Works, Eastman Kodak Company, Rochester, New York, was graduated from the U. S. Military Academy in 1910. Following a career in the Corps of Engineers, he served on many public works, boards, and planning commissions. In 1934 he became superintendent of engineering and maintenance of the Kodak Park Works and was responsible for as many as 2700 employees engaged in design, construction, and maintenance of buildings, machinery, and equipment. In 1943 he served as general superintendent of engineering in service of Holston Ordnance Works. Colonel Brown has written many papers on engineering and city planning and is an authority on industrial engineering.

The status of bills before the Congress relating to manpower were reviewed for the benefit of the Commission. Opinion was expressed that the outlook for industry in securing enough engineering graduates to meet their urgent needs was not bright and that the ultimate effects on industry would be severe.

A letter to Gen. George C. Marshall, setting forth the views of the Engineering Manpower Commission of EJC, was read and amended. The letter said that the situation in respect to the recall of reservists was a critical one for the nation and for industry and called for "new and aggressive measures." It proposed "the establishment of a competent board at the level of the Secretary of Defense, composed of technically qualified personnel from the Armed Forces, and from the civilian activities of the nation. This Board should have responsibility for the development of policy and final authority for the calling of technically trained personnel to active duty."

Consideration was given to a draft of Bulletin No. 1, a statement by the Commission on the Selection and Utilization of Technically Trained Personnel. This bulletin is to be issued for the guidance of employers of technically trained personnel and others. It covers such subjects as special Selective Service procedure pertaining to college students and current college graduates, general occupational deferment procedures under Selective Service, the recall of reservists to active duty, and essential activities and critical occupations lists. When the bulletin is published, it will be widely distributed and receive extensive publicity.

A pamphlet, "The Critical Shortage of Engineers" was exhibited. This pamphlet is to be distributed in large numbers to the principals, teachers of science, and teachers of mathematics in some 23,000 high schools.

It was announced that the proposed convocation on manpower under the sponsorship of the Engineering Manpower Commission had been postponed until fall. A planning committee is to be appointed to work up the details of the convocation.

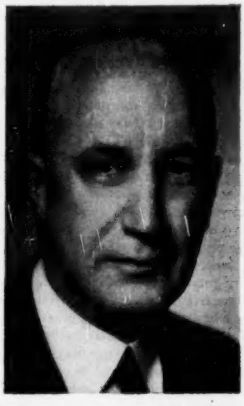
Top-Level Government Manpower Board Recommended by EJC Commission

ESTABLISHMENT of a competent board on the level of the Secretary of Defense, composed of technically qualified people, both military and civilian, and having final authority for calling technically trained personnel to active duty, was urged as necessary to national safety, by Carey H. Brown, chairman of Engineering Manpower Commission of Engineers Joint Council, in a letter to Gen. George C. Marshall, Secretary of Defense, made public recently.

Grave consequences of dissipation and wasteful use of the nation's trained and skilled young men were pointed out by Mr. Brown as reasons for the Commission's recommendations.

"The Engineering Manpower Commission of Engineers Joint Council is deeply concerned over the lack of a long-term policy on the part of the Federal Government concerning the selection and utilization of technical and scientific personnel in the defense effort," Mr. Brown said. "The sudden demand on the Armed Services resulting from the Korean crisis gave little opportunity for the formulation of long-term policy, but now that we face mobilization for an indefinite period, such a policy must be drawn up and put into effect."

CAREY H. BROWN, CHAIRMAN, EJC ENGINEERING MANPOWER COMMISSION



E. G. BAILEY, WHO SERVED AS TEMPORARY CHAIRMAN OF THE EJC COMMISSION

Problem of Reserves

"Indiscriminate recall to active status of reserves and failure properly to use their professional knowledge will dissipate, in fact is now dissipating a critical asset that is already in short supply," the letter continued. "About 25 per cent of the engineers and scientists in our nation are in reserve status. It is also to be noted that the majority of these are in an age group from 25 to 33 years. To remove a large proportion of these scientists and engineers will have a proportionately destructive effect on the strength of our technology now and in the future. The great magnitude of the problem is thus evident.

"As has been generally recognized, only through careful utilization of technical ability and the products and services it conceives can we, as a nation, hope to emerge successful against a force of vastly superior numbers. Some of this technical ability must be in the military; some must be in industry. The problem is to secure the proper allocation and most effective use of available technical manpower.

"Any satisfactory policy must recognize that the strength of the nation rests not only on one pillar, the Armed Services; but also on another, its ability to equip its armed services with the most effective equipment modern technology can produce. This means that every technical and professional man whether in reserve status or not, must be used where his contribution is worth most to national security.

"Employers of scientific and engineering personnel report that decisions with regard to recall of reservists are being made with little regard and with little, if any, understanding of the eventual effect on the industrial mobilization potential of the nation. The individuals making such decisions have inadequate understanding of the role of the reservist in his civilian position as it relates to the national production potential. The policies themselves which frequently govern decisions do not take into account the fact that a greater degree of mobilization is approaching, and if carried out to the full would leave this nation incapable of increasing its production and its development of new weapons.

Situation Called Critical

"This situation is critical. Reservists are being called to duty continually. Those who have been granted a delay in their call to duty are being told that such delays are only temporary and will seldom be renewed. It is of the utmost importance that this situation be given the most serious attention commensurate with the grave danger to our productive strength which is inherent in it. Otherwise there is the serious probability that with many of their nerve centers destroyed, industry, education, and the government's own scientific and engineering activities will suffer a partial paralysis, and will be unable to meet the great challenges which the future seems certain to hold.

"The Engineering Manpower Commission of Engineers Joint Council is convinced that the importance and magnitude of this problem demand new and aggressive measures. These measures should be based on the needs of full-scale mobilization since it would be fatal to limit potentialities of our industry for M-day by policies which will progressively reduce their maximum capacity to produce. Judgments with regard to the greater value to the national effort of the services of each reservist, and other members of the Armed Services, whether it shall be in uniform or not, must be made by persons equally cognizant of the value of his role in the two capacities.

"This will require the establishment of a competent board at the level of the Secretary of Defense, composed of technically qualified personnel from the Armed Services and from the civilian activities of the nation. This Board should have responsibility for the development of policy and final authority for the calling of technically trained personnel to active duty."

General Marshall's Reply

On April 4 General Marshall replied to the EJC letter delivered by Dr. Trytten, as follows:

"I appreciate having the benefit of your thinking on the reserve recall problem and your suggestion that a board 'composed of technically qualified personnel from the Armed Services and from the civilian activities of the nation' be established in my office to develop policy and criteria, as well as have final authority for the calling of technically trained personnel to active duty.

"As you probably know, Assistant Secretary Rosenberg has been considering the establishment of a deferment review board at Department level and has requested assistance from Dr. Trytten and other members of your Council in developing a method of screening cases at lower levels so that only the more important ones would be referred to the top-level group. Clearly, it would not be possible for such a board to personally weigh and judge each case that would come up to it from the three Services if the right of appeal were available to all cases covered by the Labor Department List of Critical Occupations and the Department of Commerce List of Essential Activities. The important function of the Board under such circumstances might well be buried by an impractical administrative load.

"The Department of Defense is devoting every effort to giving substance to the President's National Manpower Mobilization Policy as related to the recall of reservists. I know that Mrs. Rosenberg will appreciate your assistance and your understanding of the complexities of the problems."

Members of EJC Manpower Commission

Members of the Engineering Manpower Commission of Engineers Joint Council represent the country's leading organizations of engineers as well as outstanding industries as follows:

Carey H. Brown, chairman, Eastman Kodak Company; Thomas A. Marshall, Jr., executive secretary, Engineering Manpower Commission.

American Society of Civil Engineers: W. N. Carey, executive secretary; George W. Burpee, Coverdale & Colpitts; Leslie G. Holleran, Clarke, Rapuano & Holleran; D. W. Winkelman, D. W. Winkelman Company, Inc.

American Institute of Mining and Metallurgical Engineers: Edward H. Robie, secretary; George B. Corless, Standard Oil Company (N. J.); Max W. Lightner, Carnegie-Illinois Steel Corporation; Harry J. O'Carroll, Kennecott Copper Corporation.

American Institute of Chemical Engineers: S. L. Tyler, secretary; W. I. Burt, B. F. Goodrich Company; C. G. Kirkbride, Houdry Process Corporation; Norman Shepard, American Cyanamid Company.

The American Society of Mechanical Engineers: C. E. Davies, secretary; E. G. Bailey, Babcock & Wilcox Company; George W. Codrington, General Motors Corporation; R. E. Gillmor, Sperry Corporation.

American Institute of Electrical Engineers: H. H. Henline, secretary; O. W. Eshbach, Northwestern Technological Institute; A. C. Monteith, Westinghouse Electric Corporation; H. A. Winne, General Electric Company.

American Society for Engineering Education: Arthur B. Bronwell, secretary; Henry H. Armsby, Office of Education; S. C. Hollister, Cornell University; Thorndike Saville, New York University.

Engineers Joint Council Meets on March 16

THE Engineers Joint Council held its regular meeting in the Engineering Societies Building, New York, N. Y., on March 16, 1951. James E. Todd, past-president ASME, and chairman EJC, presided.

Report of Executive Committee

The executive committee reported through Mr. Todd that T. E. Purcell had been asked to head a committee to follow legislation relating to air pollution and to appoint other engineers to serve with him. It had also asked Everett S. Lee to make a study of possible EJC interest in patent protection and to report to the committee.

C. E. Davies, secretary ASME, reported that he was engaged in preparing a factual summary of important events and actions of the former American Engineering Council and that it was proposed to bind the records of AEC and deposit them in the Engineering Societies Library.

Acceptance had been voted of the invitation of the Federation of Belgian Engineering Associations (FABI) to be represented at their 25th anniversary on June 7–9, 1951.

International Relations

For the Committee on International Relations, E. A. Pratt, chairman, summarized the actions reported in the minutes of their meeting of March 2, 1951. He stressed particularly the recommendation of the Committee that each constituent society send its secretary as an official delegate to the conference, to be held in Havana, Cuba, tentatively scheduled

for April 19-22, 1951, on UPADI (Union of Pan-American Engineering Associations). Copies of a letter, signed by Lloyd J. Hughlett, chairman of the Commission on Latin America, and addressed to F. Saturnino de Brito, president of the provisional organization of UPADI, Rio de Janeiro, Brazil, in which decision to endorse UPADI and to send delegates to the Havana Conference, and setting forth certain principles on which these delegates will be instructed to work, were distributed with the minutes.

Engineering Sciences

A report of the Committee on Engineering Sciences was presented and is to be reworded. There was discussion of the personnel of the National Science Foundation Board. It was announced that Alan Tower Waterman, of the Office of Naval Research, has been nominated by the President as director of the National Science Foundation.

Unity

For the Committee on Increased Unity in the Engineering Profession it was reported that the report of the Exploratory Group had been distributed to Sections of the constituent societies for comment. (See MECHANICAL ENGINEERING, March, 1951, pp. 253-255.)

Labor Legislation

For the Labor Legislation Panel, E. L. Chandler called attention to pending legislation which was being followed by the Panel.

Fuel Resources

It was noted for the record that a monograph on an investigation of fuel resources made by the Senate Committee on Interior and Insular Affairs is in the EJC files.

Water Policy

For the National Water Policy Panel it was reported that an analysis of the Cooke report (The President's Water Resources Policy Commission) is under way and will be issued, with a reprint of the Panel's original report, in the near future. The necessity of an attractive format was stressed and suggestions regarding publicity were received.

Manpower Commission

For the Engineering Manpower Commission, E. G. Bailey, temporary chairman, presented a progress report. He announced the imminent selection of a chairman and an executive secretary. (At a meeting of the Commission on March 27, 1951, Carey H. Brown took over the chairmanship and T. A. Marshall, Jr., the executive secretaryship.) A communication on the need for engineers is under preparation and will be sent to about 25,000 high-school principals, and to equal numbers of teachers of science and mathematics.

EJC Representatives Meet With British Educators

THE relation of the American engineering profession to American engineering education at the university level was explained to a 15-man team of representatives of British education, industry, and labor by representatives of the Engineers Joint Council and the Engineers' Council for Professional Development at a meeting held in the Engineering Societies Building, March 28, 1951.

Known as United Kingdom Universities and Industries Team No. III, the group visited the United States from March 18 to April 28, under the auspices of the Anglo-American Council on Productivity and sponsorship of the Economic Cooperation Administration, to study the relationship existing between American higher institutions of learning and industry.

Team III will be followed by a fourth group of specialists whose findings will complete a study covering the entire training-for-industry program, from the indoctrination of the novice to the highest levels of management.

Specific interests of Team No. III were to investigate: (*a*) Facilities available for refresher courses both for faculty and management personnel; (*b*) higher technological training facilities available both at universities and in industries; (*c*) interchange of teaching staffs; (*d*) placement of graduates and undergraduates in industry; (*e*) research co-operation between colleges, universities, and industry; (*f*) industry's part in the financing of educational institutions; and (*g*) what industry expects from the university.

Engineering Education in U. S.

C. E. Davies, secretary EJC, as spokesman for American engineering societies, discussed the activities of organized bodies of engineers in relation to students, the faculty, the educational process, and the research in educational institutions.

He defined the education of an engineer as a long process in the development of a man who is soundly grounded in the fundamental sciences and who has some appreciation of impact of his work on the social and economic life of his times.

Touching on the relation of the engineering society to students, Mr. Davies said that while each society had a somewhat different program, they are basically similar. All societies agree that the profession has a responsibility to show an intelligent interest in the student's growth in professional life.

Members of engineering faculties have traditionally held positions of leadership in American engineering societies, he said. Society publications provide them with an outlet for papers, and society meetings provide opportunities for acquainting educators with current practices and industrial leaders.

Mr. Davies also recounted the development of the ECPD, EJC, and the American Society for Engineering Education.

Prior to meeting with the engineering societies, the British team had visited Brooklyn Polytechnic Institute and the Cooper Union School for the Advancement of Science and Art, and had listened to an exposition of industrial training as practiced by the General Electric Corporation. The group also visited Princeton University. Before departing for England, the team was scheduled to visit several other American universities and large companies which maintain training programs.

The British Team

Members of the British team are: David S. Anderson, director, Royal Technical College, Glasgow; Frederick Bray, undersecretary, Ministry of Education, London; William S. Bristowe, head, central staff department, Imperial Chemical Industries, Ltd.; Percy Dunsheath, *Team Leader*, director, W. T. Henley's Telegraph Works Company, Ltd.; Arthur L. Fleet, *Team Secretary*, assistant secretary and registrar, Association of Universities of British Commonwealth; Edmund Giffen, head, department of civil and mechanical engineering, Queen Mary College, University of London; Oswald V. Guy, secretary, appointments board, Cambridge University; Prof. Daniel T. Jack, professor of economics, University of Durham, King's College, Newcastle upon Tyne; John C. Jones, director of education, Polytechnic, London; Norman G. McCulloch, director, Calico Printers' Association, Ltd.; Prof. Harry W. Melville, professor of chemistry, University of Birmingham; Charles R. Morris, vice-chancellor, University of Leeds; William F. F. Scott, director, Tube Investments, Ltd.; Donald R. O. Thomas, chief education officer, United Steel Company Ltd., Sheffield; and John Vernon C. Wray, secretary of education department, British Trades Union Congress. Theodore H. Robinson, Economic Cooperation Administration, New York, N. Y., was project manager.

American representatives were: W. N. Carey, secretary, American Society of Civil Engineers; E. H. Robie, secretary, American Institute of Mining and Metallurgical Engineers; C. E. Davies, secretary EJC and The American Society of Mechanical Engineers; H. H. Henline, secretary, American Institute of Electrical Engineers; S. L. Tyler, secretary, American Institute of Chemical Engineers; Thorndike Saville, past-president ASEE and dean of engineering, New York University; E. A. Pratt, chairman, EJC Committee on International Relations.

National Manpower Council Established by Columbia U.

A NATIONAL Manpower Council was recently established by Columbia University, New York, N. Y., to undertake "a continuing appraisal of America's manpower resources." The Council, which is being financed by a grant of $100,000 from the Ford Foundation, will be headed by James D. Zellerbach, president of Crown Zellerbach Corporation, San Francisco, Calif. Mr. Zellerbach was formerly chief of the Economic Cooperation Administration Mission to Italy.

The objectives of the Council will be: (1) To identify and evaluate the major areas in

which significant manpower wastes now occur; (2) to determine methods for improving the present utilization of the nation's manpower; and (3) to make recommendations aimed at developing the unused potential of existing manpower resources.

The administrative and research work of the Council will be under the auspices of the Graduate School of Business at Columbia, and Dean Philip Young will serve as deputy chairman of the Council.

Other universities, as well as various governmental departments, will play active roles in the work of the Council. Secretary of Labor Maurice Tobin and Assistant Secretary of Defense Anna Rosenberg have both pledged full co-operation of their respective departments.

National Defense Program Is Creating Opportunities for Women Engineers

THE growing need for persons with engineering aptitudes is creating opportunities for women in the predominantly masculine field of engineering, according to Beatrice Hicks, president of the Society of Women Engineers. Miss Hicks spoke at the Third Annual Conference of the SWE held recently at the Hotel Barbizon, New York, N. Y.

The SWE was organized one year ago for the purpose of making the public aware of the availability of women engineers, to foster congenial relations between women engineers and industry, to encourage professional advancement, and to provide engineering information which is not otherwise readily available. The Society has sections in major cities. Its members are women educated or professionally active in design, development, research, administration, and education.

The technological aspects of modern life, Miss Hicks said, call for many more technically trained persons than at any time in history. The needed personnel will be drawn from those having engineering aptitudes whether they are men or women. She said women were already working in all phases of engineering and that it was a natural development for these women to form a society.

Women Students Welcomed

In a panel discussion on the effect of the current emergency on women in engineering, Mary F. Blade, professor of machine design, Cooper Union, said that most engineering schools when faced with dwindling numbers of incoming students will welcome girls graduating from High school who are prepared in mathematics and science and are interested in engineering. At the present time, she said, less than three in every thousand engineers are women. The opportunities for study and employment in the field were good, she stated.

In the same session, Elsie Eaves, manager, Business News Department of *Engineering News Record*, pointed out that "the current emergency has speeded up the number of opportunities open to women but was not responsible for women entering the field. Women now have an excellent opportunity to establish records which will make them permanently welcome in engineering."

At another session, Dorothy S. Potts, president, Radio Magazines, Inc., commented on the increasing number of bachelor-degree holders. This number has risen over 500 per cent since 1920 as against a 50 per cent increase in population. The college graduate is no longer an impressive figure. The man to be reckoned with now is the one with the graduate degree.

Engineering an Expanding Field

Dr. H. J. Masson, assistant dean of the graduate Division, College of Engineering, New York University, discussed the problem from an educator's point of view. "The field of engineering," he said, "has been expanding both in coverage and depth of treatment so that today the term 'technology' would be more descriptive than engineering. As a result, many topics are deleted or only incompletely treated in the undergraduate curriculum, due to lack of time or inadequate background. To provide the necessary training to engage in the frontier activities of technology, advanced training and graduate study are necessary. The inclusion of biology and medicine in the field of sanitary engineering, psychology and human relations in industrial and management engineering, together with the traditional fields, has expanded enormously the opportunity for women in engineering. Experience has shown that in certain activities women have superior aptitudes. One of these is in the field of research. However, to qualify for desirable positions where these aptitudes find their best application, graduate study is increasingly necessary."

Boston Engineers Discuss Engineering Manpower

WHAT the engineering profession was doing to insure optimum utilization of engineers for national defense was explained to Boston engineers by Stephen L. Tyler, secretary, American Institute of Chemical Engineers, at a meeting of the Engineering Societies of New England on March 30, 1951. This organization is composed of most of the Boston sections of national engineering societies.

Mr. Tyler, who was chairman of the Engineering Sciences Committee of the six committees appointed by Gen. Lewis B. Hershey, director of Selective Service System, to advise him on manpower problems, said that American engineers were attacking the engineering manpower problem as follows:

1 Activities to interest capable high-school students in the field of engineering.

2 The development of a deferment policy permitting the more capable engineering students to continue their education.

3 The development of a deferment policy which will permit engineering graduates to find work in critical industries and to continue to serve the companies with which they are connected.

4 Assistance to the Armed Services to help them to utilize the engineers which they obtain in a manner which will take best advantage of their capabilities.

5 Assistance to Senate and House committees in the preparation of new selective-service legislation.

6 Attention to the problems arising in the cases of key men in important defense industries who are members of the active reserve.

7 General studies of the number of engineers which will be required by the Armed Forces and industry and the number of engineers being developed to fill these needs.

The United States could not possibly hope to match the enemy in manpower, Mr. Tyler declared. Our superiority must be on the side of technological skills, and our strength must rest on the magnitude and quality of our defense industries.

This analysis of the situation has prompted engineers to act as follows:

1 Through the War Manpower Commission a program is being set up to maintain or increase the enrollment of engineering students.

2 Through the Advisory Committees to Selective Service a policy for the deferment of the more capable college students was worked out. These advisory committees, in addition to working on the problem of students, recommended policies whereby engineering graduates could find employment in defense industries. It also acted as an advisory committee to local selective boards and appeal boards in cases where engineers are concerned.

3 The Engineers Joint Council, composed of representatives from the Founder Societies and the AIChE, set up an Engineering Manpower Committee along with representatives from some other societies. This committee is active in working with the Armed Forces in helping to utilize engineers effectively and in the preparation of legislative amendments and bills relating to mobilization. This committee also sponsored the study of engineering-manpower needs which is presented in the widely published Hollister report (see the February issue of MECHANICAL ENGINEERING, pages 121–122).

Referring to problems of engineers in the Reserves, Mr. Tyler recommended that employers analyze the individual's contribution to the defense effort in his present position and compare it to his likely duties in the Armed Forces. If his job in industry contributes more to national defense than his task in the Armed Forces, the employer should seek his deferment. This should be done not only by correspondence but by personal visit to the department of the service in Washington.

Program for Heat Transfer and Fluid Mechanics Institute Announced

THE fourth annual meeting of the Heat Transfer and Fluid Mechanics Institute will be held at Stanford University, Stanford, Calif., June 20–22, 1951. The Institute was organized for the purpose of establishing a meeting of breadth and quality which would make a definite contribution to the scientific advancement and intellectual growth of the western community.

Institute sponsors are: California Institute of Technology, Stanford University, University of California, University of Santa Clara, University of Southern California, and the Applied Mechanics, Gas Turbine Power, Heat Transfer, and Hydraulic Divisions of The American Society of Mechanical Engineers.

The program will consist of six sessions of three papers each, or a total of 18 papers.

All papers will be preprinted in full and complete sets of preprints will be on sale at the Institute at a cost of $4. A limited number of sets of preprints will be available for purchase by mail for $5 after the Institute closes. Preprints will not be available for purchase by mail in advance of the meeting. Papers can be ordered from A. L. London, Department of Mechanical Engineering, Stanford University, Stanford, Calif.

The technical program follows:

WEDNESDAY, JUNE 20

8:30 a.m.

Registration

10:00 a.m.

Session I

Introduction: *A. L. London*, general chairman, 1951 Heat Transfer and Fluid Mechanics Institute

Diffraction of Water Waves by Breakwaters, by *J. H. Carr* and *M. E. Stelsriede*, California Institute of Technology

Hydraulics Applied to Molten Aluminum, by *D. S. Richins* and *W. O. Wetmore*, U. S. Naval Ordnance Test Station, Inyokern, Calif.

Effect of Friction on a Single Vortex Tube, by *H. A. Einstein*, University of California

2:15 p.m.

Session II

Remarks on the Theory for Convection in Porous Media, by *F. T. Rogers* and *H. L. Morrison*, U. S. Naval Ordnance Test Station, Inyokern, Calif.

The Mechanics of Drops, by *R. R. Hughes*, Shell Development Company, and *E. R. Gilliland*, Massachusetts Institute of Technology

THURSDAY, JUNE 21

9:30 a.m.

Session III

Some Experiments on Heat Transfer From a Gas Flowing Through a Convergent-Divergent Nozzle, by *O. A. Saunders* and *P. H. Calder*, Imperial College, London University, London, England

The Transient Method for Determining Heat-Transfer Coefficients in High-Velocity Flow, by *C. R. Garbett*, Stanford University

Heat Conduction in a Compressible Flow, by *J. D. Cole* and *T. Y. Wu*, California Institute of Technology

2:15 p.m.

Session IV

Turbulent Mixing of Coaxial Gas Jets, by *F. Landis*, Stanford University, and *A. H. Shapiro*, Massachusetts Institute of Technology

Variation of the Eddy Conductivity With Prandtl Modulus and Its Use in Prediction of Turbulent Heat-Transfer Coefficients, by *Rodman Jenkins*, California Institute of Technology

Internal Flow Data and a Heat-Transfer Theory for the Vortex Refrigerating Tube, by *G. W. Scheper*, Gas Turbine Division, General Electric Company

FRIDAY, JUNE 22

9:30 a.m.

Session V

Heat-Transfer, Pressure-Drop, and Burnout Studies With and Without Surface Boiling for Deaerated and Gassed Water at Elevated Pressures in a Forced Flow System, by *H. Buchberg, F. Romie, R. Lipkis*, and *M. Greenfield*, University of California at Los Angeles

Liquid Superheat and Boiling Heat Transfer, by *B. R. Mead, F. E. Romie*, and *A. G. Guibert*, University of California at Los Angeles

2:15 p.m.

Session VI

A Theory of Unstable Combustion in Liquid-Propellent Rockets, by *Martin Summerfield*, Princeton University

Transient and Steady-State Heat Transfer in Irradiated Citrus Fruits, by *H. F. Poppendiek*, Oak Ridge National Laboratory

Evaporation From a Plane Boundary, by *M. L. Albertson*, Colorado Agricultural and Mechanical College

Western Applied Mechanics Meeting Schedules Fine Program

THE first Western Meeting to be sponsored by the Applied Mechanics Division of The American Society of Mechanical Engineers will be held at Stanford University, Stanford, Calif., June 22–23, 1951.

Morning and afternoon sessions are scheduled for each day. The subjects of the four sessions will be: Vibrations and stability; plasticity; fatigue and creep; and plate and shell problems.

The following papers have already been scheduled. In addition there will be one or two longer presentations of general interest on recent research.

"Vibrations of a Clamped Circular Plate Carrying Concentrated Mass," by Robert E. Roberson. This deals with problems which arise in the mounting of instruments and their protection against shock.

"Transverse Vibration of One- and of Two-Span Beams Under the Action of a Moving Mass Load," by Robert S. Ayre, Lydik S. Jacobsen, and Chieh Su Hsu. This reports one of a series of investigations on the dynamic effect of traveling loads on beams and bridges; experimental, with theoretical controls on limiting cases.

"On the Inextensional Theory of Deformation of a Right Circular Cylindrical Shell," by R. M. Hermes. The degree of approximation involved in the inextensional theory for calculations of stress and deformation in thin shells is explored and clarified by means of strain-gage measurements.

"Bending of Thin Ring Sector Plates," by LaMar I. Deverall and Charles J. Thorne. Analytical solutions are given for several combinations of physically important edge conditions.

"Experimental Investigation to Determine the Applicability of Elementary Theory for Calculating Deflections of Swept Cantilever Plates," by H. J. Gursuhaney and H. C. Martin.

"The Behavior of Graphite Under Alternating Stress," by Leon Green, Jr. An investigation of the fatigue properties of graphite at high temperatures is reported. These are acquiring importance through the increasing use of refractory materials for engineering purposes involving structural strength.

"A General Method of Calculating the Bending Moment—Strain Diagram in Plastic Bending of Beams," by Aris Phillips. A simplified method of wide application for constructing a diagram essential for estimating plastic deformation in beams is given.

"Lateral Vibrations as Related to Structural Stability," by Harold Lurie. An experimental and analytical examination of vibration frequencies as indicators of the approach of buckling is reported.

"Nonsinusoidal Buckling Modes of Sandwich Plates," by J. N. Goodier and C. S. Hsu. This is a re-examination of the aerostructural problem of sandwich-plate stability which shows that the customary assumption of sinusoidal buckling overlooks possibilities of nonsinusoidal buckling at lower loads.

Accommodations will be available on the Stanford campus. Requests for reservations should be addressed to E. A. Ripperger, Division of Engineering Mechanics, Stanford University, Stanford, Calif.

Meetings of Other Societies

May 14–17
American Mining Congress, 1951 coal convention and exposition, Cleveland, Ohio

May 16–18
Society for Experimental Stress Analysis, spring meeting, The National Bureau of Standards and the Wardman Park Hotel, Washington, D. C.

May 23–24
American Iron and Steel Institute, general meeting, Waldorf-Astoria Hotel, New York, N. Y.

May 23–24
American Society for Quality Control, 5th annual convention, Hotel Cleveland, Cleveland, Ohio

May 27–30
American Society of Refrigeration Engineers, 38th spring meeting, Hotel Statler, Detroit, Mich.

June 3–8
Society of Automotive Engineers, summer meeting, French Lick Springs Hotel, French Lick, Ind.

June 4–6
American Gear Manufacturing Association, annual meeting, The Homestead, Hot Springs, Va.

June 4–7
Edison Electrical Institute, 19th annual meeting, Denver, Colo.

June 5–11
National Management Council, 9th international management congress, Brussels, Belgium.

June 7–8
American Management Association, general meeting, Waldorf-Astoria Hotel, New York, N. Y.

(For ASME Calendar of Coming Events see page 458)

People

ASME Elects Seven to the Grade of Fellow

THE American Society of Mechanical Engineers recently elected seven members to Fellows ASME. They are: Venton L. Doughtie, chairman of the department and professor of mechanical engineering, The University of Texas; Gustaf A. Gaffert, partner and chief mechanical engineer, Sargent and Lundy, Chicago, Ill.; J. Stanley Morehouse, dean of engineering, Villanova (Pa.) College; Rudolph E. Peterson, manager, mechanics department, Westinghouse Research Laboratories; Cyrus William Rice, president, Cyrus William Rice and Company, Inc., Pittsburgh, Pa.; Blake R. Van Leer, president, Georgia Institute of Technology; and N. T. Veatch, member of the firm of Black & Veatch, Kansas City, Mo.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council to be approved by Council.

Venton Levy Doughtie

VENTON L. DOUGHTIE was born in Montgomery County, Texas, April 22, 1897. He was educated at the Rice Institute and the University of Texas and in 1920 he received a BSME degree; in 1940 an MSME degree. Professor Doughtie's contribution to engineering has been made as a teacher and author.

After a year with Westinghouse Electric and Manufacturing Company as a technical apprentice, his teaching career in mechanical engineering began at The Johns Hopkins University in 1921 as an instructor. He taught at Texas Technological College, Lubbock, Texas, from 1930 to 1938, and since 1938 he has been on the faculty of The University of Texas, first as an associate professor. In 1939 he was made professor and in 1949 he also became chairman of the department.

His books have become standard textbooks and are in use at many engineering schools. With Prof. A. Vallance he wrote "Design of Machine Members" which is widely used in teaching machine design and as a guide in research in this field. His proficiency in mechanism and design brought about the request that he revise and prepare the sixth edition of "Elements of Mechanisms" by Schwamb, Merrill, and James, and the invitation to write section 7, "Mechanism, Mechanics, and Machine Elements," of Kent's "Mechanical Engineers' Handbook," Design and Production, 12th edition, 1950. He is the author of "Fundamentals of Engineering Problems." In addition to his books he has contributed numerous articles to technical magazines, the most recent being, with Prof. J. W. Carter, "Bolted Assemblies," which was published in *Machine Design*, February, 1950.

Gustaf Adolf Gaffert

GUSTAF A. GAFFERT was born in Worcester, Mass., Sept. 1, 1901, and graduated from the Worcester Polytechnic Institute in 1923 with a BSME degree; in 1925, an MSME degree. He received a DSME degree from the University of Michigan, 1934.

Mr. Gaffert is recognized as one of the foremost designers of public-utility power plants in the country. During the past 14 years he has been directly responsible for the engineering design of the plants of the Cincinnati Gas and Electric Company, The Illinois Power Company, at Havana, Ill., the Illinois Power Company, at Wood River, Ill., and more than ten other large plants throughout the country. The total installed capacity of these plants is 1,000,000 kw.

Early in his career Mr. Gaffert was an instructor in mechanical engineering at the University of Illinois. From 1934 to 1936 he was assistant professor of heat-power engineering at Worcester Polytechnic Institute and developed heat-power and ventilation courses.

He is the author of "Steam Power Stations" which has become a standard on the subject and is used as a reference by engineers and as a textbook in some 40 colleges and universities; coauthor of section 10, "Standard Handbook for Electrical Engineers," 7th and 8th editions; and his articles have been published in technical and scientific journals.

Mr. Gaffert was a member of the ASME Power Division and twice has been its chairman. He has served as secretary of the ASME Special Standards Committee on Steam Turbines since 1944.

J. Stanley Morehouse

J. STANLEY MOREHOUSE was born in Amenia, N. Y., November 19, 1894. Dean Morehouse has been at Villanova since 1921, when he was graduated from Stevens Institute of Technology with an ME degree, starting as an instructor in mechanical engineering.

Early in February, 1941, and continuing through 1945, under the sponsorship and auspices of the United States Office of Education, Dean Morehouse organized at Villanova College and directed engineering defense training courses in industry. He then organized and directed similar courses at ten locations in metropolitan Philadelphia. Among these were: Cramps Shipbuilding Company, United States Navy Yard, Temple University, Philadelphia Electric Company's plants in Philadelphia and Chester, Pa., and at several local high schools. Special courses in 25 subjects were organized and a total of 407,975 student-hours of instruction given. It became evident early in the program that difficulty would be experienced in securing competent instructors which led to courses which were organized at Villanova College, under the direction of Dean Morehouse, to train as teachers, engineers who had never before taught formal classes. In all, 157 were trained for Villanova College, Temple University, Drexel Institute of Technology, and Swarthmore College.

He has designed and supervised the construction and outfitting of engineering and naval research laboratories and power plant at Villanova. He is a member of the Evaluation Committee of the Middle Atlantic States Association of Colleges and Secondary Schools and of many technical and honorary societies. Dean Morehouse has been an active member of ASME and served on national and local Philadelphia Section committees. He is the author of "Kinematics of Machines," "Heating, Ventilating, and Air Conditioning," and several technical articles.

Rudolph Earl Peterson

RUDOLPH E. PETERSON was born in Oregon, Ill., Nov. 8, 1901. He was graduated valedictorian from the University of Illinois in 1925 and received a BSME degree (with honors) MS, 1926.

Mr. Peterson's contributions to engineering have been in the fields of gearing theory and in mechanics of materials, particularly fatigue and stress-concentration effects, fracture analysis, and the relation between laboratory tests and service failures. As an administrator of research in the field of mechanics he has directed an organization with facilities for research in mechanics of materials, photoelasticity, dynamics, theoretical stress analysis, lubrication, and combustion. The accomplishments under his leadership have been outstanding as Mr. Peterson has always surrounded himself with men of exceptional ability. His department has worked on many important mechanical-engineering developments among which are: the Dynetric machine for balancing of rotating equipment, which resulted in balancing becoming a production-line technique; the dynamic mounting of the Laundromat; the magnetic strain gage; and advances in three-dimensional photoelasticity. During World War II his department was active in the initial stages of turbojet development and the design of equipment for isotope separation in the atomic-bomb project. He is the author of more than 40 papers.

As a firm believer and active worker in technical societies, Mr. Peterson has served ASME in many capacities for the past 24 years. In 1926 he won the ASME Junior Award. He has been especially noted for his work in the Applied Mechanics Division. Since 1948 he has been a member, and is now secretary of the Executive Committee of the Division. He served on the Meetings Committee, 1948–1950. He is also a member of the ASME Managing Committee and chairman of the Advisory Board, *Applied Mechanics Reviews*. He is chairman of the Committee on Mechanics Symbols of the ASA, is a past-president of the SESA, and is chairman of the Fatigue of Metals Committee of the ASTM.

Cyrus William Rice

CYRUS WILLIAM RICE was born in Ringtown,

Pa., May 28, 1875, and attended Jefferson Medical College, Philadelphia, Pa., 1892 to 1894.

Mr. Rice received his earliest training and experience in the treatment of water for boiler feed while he was employed by the Carnegie Steel Company from 1901 to 1903. In 1904, when he went with the Atlantic Refining Company in Philadelphia, Pa., he pioneered and developed outstanding new methods, which were patented, for the treatment of river water and sewage. He was successful in setting up on a large practical scale the application of daily chemical testing and adjustment of treatment in accordance with the findings. He also developed the method of water treatment based on the principle of large-volume recirculation and air agitation to improve and speed up the lime-soda softening process. Later this principle was used by a number of cities for sewage treatment. He developed several of the most fundamental water-softening and clarifying methods.

In 1916 Mr. Rice started his own company to supply consulting service on water-treatment problems. He developed and marketed a water-analyzer outfit, with instruction book, for use by plant operators in setting up and controlling the treatment of boiler water. He promoted the use of scientific chemistry for the treatment of boiler water as opposed to the "patent-medicine" type of treatment. He developed and promoted the use of many additional refinements of substantial value in water treatment. He recently designed a compact, continuous, acid and cyanide waste-disposal system. He holds 15 patents pertinent to water-treatment methods and apparatus.

He has been a member of the subcommittee for the Care of Steam Boilers, and other Pressure Vessels in Service, since 1923, and is now chairman of the Chemical Section of this committee. He is a member of the Steering Committee of the Mechanical Section.

He has long been recognized as an outstanding expert on feedwater by his fellow members.

Blake Ragsdale Van Leer

Blake R. Van Leer was born in Mangum, Texas, Aug. 16, 1893, and was graduated from Purdue University, 1915, with a BSEE degree. In 1920 he received from the University of California an MSME degree; in 1922, Purdue University, ME. He studied at the University of Caen, France, in 1919, and at the University of Munich, Germany, 1927–1928.

Dr. Van Leer began his career in 1915 at the University of California as an instructor, and was later promoted to assistant professor of mechanical engineering. He was there until 1928, except for a period of service in World War I, and in addition to his work on the campus he served as an engineer with C. L. Cory, consulting engineer; Byron-Jackson Pump Company; and Southern Pacific Railroad. From 1928 to 1932 he was assistant secretary of the American Engineering Council, Washington, D. C., and at the same time he was a part-time lecturer in hydraulics at George Washington University. In 1932 he was appointed dean of engineering at the University of Florida. North Carolina State College, Raleigh, N. C., appointed Dr. Van Leer as dean of engineering in 1937. He assumed his position when all engineering courses given at the University of North Carolina and North Carolina State College were consolidated at the latter institution. Under his administration all engineering courses were improved and brought up to date. After his service in World War II, as chief of the Facilities Branch, Army Specialized Training Program, Washington, D. C., the Board of Regents selected Dr. Van Leer, in 1944, as president of the Georgia Institute of Technology.

Under his leadership, Georgia Tech has expanded not only in activities and services, but also in size and prestige. In addition to his engineering and research administrative duties he has always found time to serve as consultant on many government, local, civic, and professional engineering projects.

He received an honorary DS degree from Washington and Jefferson College in 1943, and DE from Purdue University in 1944. He is a member of many technical and honorary societies. He is the author of many articles and reports.

Nathan Thomas Veatch

N. T. Veatch was born in Rushville, Ill., on Aug. 25, 1886, and received his education at the University of Kansas, graduating in 1909 with a BSCE degree, and in 1924 he received a CE degree.

From his graduation until 1914, he was with the J. S. Worley Company and Worley & Black, consulting engineers, predecessors of the firm of Black & Veatch, on various construction work in Kansas. He also was an instructor at the University of Kansas, assigned to the State Board of Health. He was associated with the American Water Works and Guarantee Company in charge of the water-works property at Keokuk, Iowa.

The firm of Black & Veatch established a consulting-engineering practice in January, 1915, serving municipalities, government, and private industry in the utility field. Water supply, sewerage, electric generation and distribution, natural-gas distribution, together with special investigations, rate studies and appraisals of these utilities, have constituted the major work of the firm. Mr. Veatch has actively participated in the work of the firm and has personally directed many of the major engagements.

The Federal Government was served in World Wars I and II on various cantonments, air fields, and so on; the U. S. Atomic Energy Commission is now using the firm on work at Los Alamos, N. Mex., and other places in the United States.

Mr. Veatch is a past-president of the American Water Works Association and, by appointment of President Truman, is the engineer member of the National Water Pollution Control Advisory Board of the United States Public Health Service. He is a member of several honorary societies. He holds a citation from the University of Kansas for having brought honor to the University by reason of long, distinguished service in his own field. He is a registered professional engineer in 23 states, a member of the American Institute of Consulting Engineers, the American Society of Civil Engineers, the American Society for Testing Materials, and American Public Works Association. He was elected to ASME in 1921.

James C. Floyd, winner of 1950 SAE Wright Brothers Medal

Canadian Wins SAE 1950 Wright Medal

James C. Floyd, chief design engineer for Avro Canada transport aircraft, has been awarded the Wright Brothers Medal of the Society of Automotive Engineers, it was announced recently. This is the first time the award has been given to a Canadian. It was given specifically for a paper on the Avro Canada Jetliner, America's only jet transport, which Mr. Floyd delivered to the SAE at a meeting in Detroit, Mich., in January, 1950.

Mr. Floyd has been engaged on the design of many notable aircraft types, apart from the Jetliner. These include the Anson and the Lancaster. He also took part in the design of the York transport in which he made numerous test flights. At Avro Manchester, where he received his early training, he was in charge of the stressing of the York and was engaged on liaison work between Avro Manchester and the Royal Aircraft Establishment test center at Farnborough.

From 1935 to 1936 he was loaned to the Hawker Aircraft Company to work on the design of the experimental Hawker Hotspur. His last position in England, before coming to Avro Canada in 1946, was that of chief project engineer, at the Yeadon Plant of Avro Manchester. He is now a Canadian citizen.

He is an Associate Fellow of the Royal Aeronautical Society and a member of the Institute of the Aeronautical Sciences.

ASME NEWS

Excellent Program Arranged for 1951 ASME Semi-Annual Meeting

Toronto, Ont., Can., June 11–15

THE American Society of Mechanical Engineers will be guests of the ASME Ontario Section during the 1951 Semi-Annual Meeting of the Society, to be held at the Royal York Hotel, Toronto, Ontario, Can., June 11–15, 1951. This meeting represents the third time the Society has held a national meeting in Canada. In 1932, the Semi-Annual Meeting was held at Bigwin Inn, Lake of Bays, Can., and in 1943, the Fall Meeting was held in Toronto.

An attraction in Toronto during the week preceding the ASME meeting, which will add considerable color and excitement to a Canadian vacation, is the Canadian International Trade Fair. Many members of the Society will probably arrive early to take advantage of the opportunity to see the exhibits featuring merchandise of some 33 countries arranged in 20 different trade classifications. The first U. S. international trade fair held in Chicago recently excited considerable interest. The opportunity to inspect the products of industrial skills of countries overseas, arranged conveniently within a few buildings, should not be missed.

The technical program will consist of 38 technical sessions, luncheons, dinners, and inspection trips. The Engineering Institute of Canada has been invited to cosponsor several social events and technical sessions.

The Semi-Annual Meeting is one of the major administrative events of the Society. Concurrently with the technical program, Society officials will be meeting to plan for future programs. The National Nominating Committee will announce during the course of the meeting, nominees for president, four vice-presidents, and two directors at large.

In another part of the hotel, the National Delegates Conference, composed of two representatives from each ASME Region, will consider an agenda composed of items relating to Society Administration suggested by local Sections. The Council of the Society, top-level administrative body, will also meet. One of its major items of business will be to consider the budget for 1951–1952.

Junior Conference

On Monday evening, June 11, the National Junior Committee will sponsor a conference on the subject, "A Current Plan for Young Engineers." Carey H. Brown, chairman, EJC Engineering Manpower Commission, and general superintendent, service department, Kodak Park Works, Eastman Kodak Company, Rochester, N. Y., will discuss the impact of the current shortage of engineers on the professional careers of young engineers.

Also on the program will be 14 junior representatives, one from each of the Sections in ASME Region V, who will attend the conference as guests of the Old Guard Committee.

The National Junior Committee sponsors conferences at each of the four national meetings of the Society. For a report on the conference held at the Spring Meeting, see page 457.

Roy V. Wright Lecture

C. J. Mackenzie, chairman, National Research Council, Ottawa, Can., has been invited to deliver the Roy V. Wright Lecture. This lecture was established in 1949 to honor Mr. Wright, president of the Society in 1931, for his work in urging good citizenship on the part of engineers. Frank H. Neely, chairman of the board, Rich's Inc., Atlanta, Ga., delivered the Roy V. Wright Lecture at the 1951 Spring Meeting.

Plant Trips

The ASME Ontario Section has arranged five interesting trips to representative industries in the Toronto area. On Tuesday, members will have an opportunity to see the Maclean-Hunter Publishing Company, a modern printing establishment which publishes over 30 high-quality magazines. The plant is a five-acre building with a water-cooled roof, heat-absorbing glass, and completely air-conditioned. Members will see the large array of typesetting machines, multicolor presses, and folding, stitching, and labeling machines.

The Massey-Harris Company, manufacturers of agricultural machinery for over 100 years, with plants in 52 countries, will be host to a party of members. Of particular interest will be the specially developed techniques and latest equipment for fabrication, heat-treatment, and subassembly of parts.

The third visit is planned to the Christie Brown Biscuit Bakery where novel production line techniques in a new structure covering $4^1/_2$ acres will be on view. In addition to the plain and fancy biscuits produced, the main object of interest will be the mechanical equipment which automatically mixes, forms, bakes, ices, and packs the product.

A visit to the Ontario Research Foundation and the University of Toronto Mechanical Building will introduce members to modern Canadian testing laboratories and educational facilities.

The fifth tour will be to the A. V. Roe Canada, Ltd., where a flying demonstration of jet-propelled aircraft has been arranged.

Women's Program

Wives of members have been invited to come to Toronto for the Semi-Annual Meeting as part of the summer vacation. An interesting program has been arranged by the women of the Ontario Section. This will include a tour of the Christie-Brown Biscuit Bakery, a visit to the University of Toronto, and to historic and cultural points of interest. Each day a luncheon will be held at well-known Toronto eating places including the Royal Canadian Yacht Club on Toronto Island.

MONDAY, JUNE 11

8:00 a.m.

Registration

9:30 a.m.

Production Engineering (I)—Metal Cutting Data (I)—Cutting Fluids (I)

Forces in Dry Surface Grinding, by *E. R. Marshall,* professor, department of metallurgy, and *Milton C. Shaw,* assistant professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass. (51—SA-8)

The Size Effect in Metal Cutting, by *E. R. Marshall,* professor, department of metallurgy, Massachusetts Institute of Technology, Cambridge, Mass., *W. R. Backer,* Linde Air Products Division, Union Carbide and Carbon Corporation, Buffalo, N. Y., and *M. C. Shaw,* assistant professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass. (51—SA-9)

THE A. V. ROE CANADA, LTD., PLANT WHERE THE VISITORS WILL SEE THE FLYING DEMONSTRATION OF THE AVRO JETLINER AVRO CF100 AND THE ORENDA-LANCASTER

Surface Temperatures in the Grinding Process, by *J. O. Outwater,* E. I. du Pont de Nemours and Company, Wilmington, Del., and *M. C. Shaw,* assistant professor of mechanical engineering Massachusetts Institute of Technology, Cambridge, Mass. (51—SA-10)

9:30 a.m.

Hydraulic (I)—EIC

Studies of Submergence Requirements of High Specific Speed Pumps, by *H. W. Iversen,* assistant professor, mechanical engineering, University of California, Berkeley, Calif.

Hydraulic Problems Encountered in the Intake Structures of Vertical Wet Pit Pumps and Methods Leading to Their Solution, by *W. H. Fraser,* engineer, Worthington Pump and Machinery Corporation, Harrison, N. J.

9:30 a.m.

American Rocket Society (I)

Rocket Application of the Cavitating Venturi, by *L. N. Randall,* rocket test supervisor, Propeller Division, Curtiss-Wright Corporation, Caldwell, N. J.

Equipment for Handling High-Strength Hydrogen Peroxide, by *Noah S. Davis, Jr.,* manager, and *John H. Keefe, Jr.,* project supervisor, Buffalo Electro-Chemical Company, Inc., Buffalo, N. Y.

Optical Methods of Rocket Motor Evaluation, by *Kurt Stehling,* Bell Aircraft Corporation, Buffalo, N. Y.

9:30 a.m.

Management (I)

Economic Basis of Engineering Design and Planning, by *R. S. Steinbock,* Utilities Engineer, Imperial Oil, Ltd., Sarnia, Ont., Can.

Nonproductive Time and Its Practical Implications, by *Adam Abruzzi,* adjunct assistant Professor, Stevens Institute of Technology, Hoboken, N. J.

12:15 p.m.

President's Luncheon

Presiding and Speaker: The President, J. Calvin Brown.

2:30 p.m.

Production Engineering (II)—Management II

The Theory and Practice of Cost Reduction, by *C. A. Peachey,* works manager, Northern Electric Company, Montreal, Que., Can.

Preventive Maintenance on Press Metal Tools and Equipment, by *Edward Griffiths,* consulting manufacturing engineer, Westinghouse Electric Corporation, Pittsburgh, Pa. (51—SA-16)

The Maintenance Grinding of Cutting Punches and Dies, by *Harold B. Elliott,* manager of methods engineering, Northern Electric Company, Ltd., Montreal, Que., Can. (51—SA-26)

2:30 p.m.

Hydraulic (II)

Centrifugal Jet-Pump Combinations, by *James W. McConaghy,* engineer, Cameron Pump Division, Ingersoll-Rand Company, Phillipsburg, N. J.

Nondimensional Compressor Performance for Range of Mach Numbers and Molecular Weights, by *Herman E. Sheets,* engineer, Goodyear Aircraft Corporation, Akron, Ohio. (51—SA-19)

2:30 p.m.

American Rocket Society (II)

Uncooled Rocket Motors

Materials for Use in Uncooled Liquid-Propellant Rocket Motors, by *W. R. Sheridan* rocket section engineer, Bell Aircraft Corporation, Buffalo, N. Y.

The Success of Ceramic-Lined Rocket Motors, by *H. Z. Schofield,* supervisor, and *W. H. Duckworth,* assistant supervisor, Ceramic Division, Battelle Memorial Institute, Columbus, Ohio

Silicon Carbide Linings for Uncooled Rocket Motors, by *K. C. Nicholson,* supervising engineer, Research and Development Department, The Carborundum Company, Niagara Falls, N. Y.

5:00 p.m.

Business Meeting

8:00 p.m.

Junior

Junior Conference on the Subject: A Current Plan for Young Engineers. Speaker: *Carey H. Brown,* general superintendent, Service Department, Kodak Park Works, Eastman Kodak Company, Rochester, N. Y.

Junior Representatives Guests of the Old Guard

Akron Section A. F. Weber	Detroit Section David J. Cronberger
Canton-Alliance-Massillon Section George E. Kaufman	Erie Section John E. Tormey, Jr.
Cleveland Section Donald L. Lynch	Ontario Section John D. Bourns
Cincinnati Section Robert W. Howorth	Pittsburgh Section John T. Bunting
Columbus Section Owen E. Buxton, Jr.	Toledo Section Ernest W. Weaver, Jr.
Dayton Section David M. Goldzwig	West Virginia Section Frank J. Butler

Youngstown Section
Don Block

TUESDAY, JUNE 12

9:30 a.m.

Petroleum (I)

Piping Flexibility Analysis by Model Tests, by *Lale C. Andrews.* pipe stress analyst and consultant on high-temperature piping, The M. W. Kellogg Company, New York, N. Y. (51—SA-24)

Stress Conditions in Flanged Joints for Low-Pressure Service, by *Everett O. Waters,* professor of mechanical engineering, Mason Laboratory, Yale University, New Haven, Conn., and *Frank S. G. Williams,* manager, Engineering Standards Taylor Forge and Pipe Works, New York, N. Y. (51—SA-4)

Some Aspects of the Design and Economic Problems Involved in Safe Disposal of Inflammable Vapors From Safety-Relief Valves, by, *S. Chesler,* piping engineer, and *B. W. Jesser,* head, Analytical Section of Piping Division, The M. W. Kellogg Co., New York, N. Y. (51—SA-18)

9:30 a.m.

Production Engineering (III)—Metal Cutting Data (II)—Cutting Fluids (II)

The Reliability of Metal-Cutting Data, by *L. V. Colwell,* associate professor of metal processing, University of Michigan, Ann Arbor, Mich.

The Drilling of Cast Iron with Cemented Carbide-Tipped Drills, by *E. G. Weller,* General Electric Company, Schenectady, N. Y., and *F. W. Lucht, Jr.,* development engineer, Carboloy Company, Inc., Detroit, Mich.

9:30 a.m.

Fuels (I)

Symposium on Non-Fuel Uses of Solid Fuel

Uses of Bituminous Coal, by *Harold J. Ross,* vice-president and director of Research, Bituminous Coal Research, Inc., Pittsburgh, Pa.

Uses of Anthracite, by *Raymond C. Johnson,* vice-president in charge of research, Anthracite Institute, Wilkes-Barre, Pa.

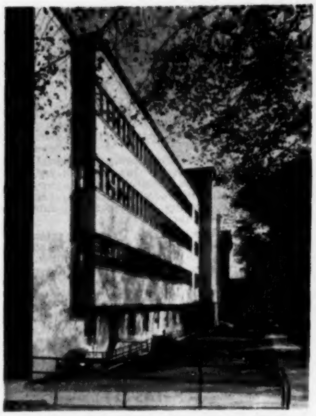
9:30 a.m.

Education

The Training of Young Graduate Engineers in Industry From the standpoint of a Canadian company, From the standpoint of an American company.

Official Notice
ASME Business Meeting

The Semi-Annual Business Meeting of the Members of The American Society of Mechanical Engineers will be held on Monday, June 11, 1951, at 5:00 p.m. Hotel Royal York, Toronto, Ont., Can., as part of the Semi-Annual Meeting of the Society.



THE ONTARIO RESEARCH FOUNDATION AND THE UNIVERSITY OF TORONTO MECHANICAL BUILDING FEATURING THE NEWEST IN EQUIPMENT AND FACILITIES

9:30 a.m.

Process Industries

Problems Arising in Storage and Handling of Pulverized Material, by *Francis Silver,* vice-president and engineer, John W. Bishop Company, Martinsburg, W. Va.

9:30 a.m.

Gas Turbine Power (I)—Aviation (I)

AVRO-ORENDA Jet-Propulsion Engine, by *P. B. Dilworth,* chief engineer, Gas-Turbine Division, A. V. Roe, Canada, Ltd., Toronto, Ont., Can.

Hi-Speed Cascade Testing Technique, by *F. H. Keast,* chief aerodynamacist, A. V. Roe, Canada, Ltd., Toronto, Ont., Can.

12:15 p.m.

Roy V. Wright Luncheon and Lecture

Presiding: The President, J. Calvin Brown,

Lecturer: C. J. Mackenzie, Chairman, National Research Council, Ottawa, Ont., Can.

2:15 p.m.

Plant Trips

Maclean-Hunter Publishing Company, The Massey-Harris Company, Christie-Brown Biscuit Bakery, The Ontario Research Foundation, and The University of Toronto Mechanical Building, and A. V. Roe, Canada, Ltd. Buses for the trip to A. V. Roe, Canada, Ltd. will leave the Royal York Hotel promptly at 1:30 p.m.

WEDNESDAY, JUNE 13

9:30 a.m.

Petroleum (II)—Lubrication—Machine Design (I)

The Catalytic Effect of Several Metals on the Oxidation of Lubricating Oils, by *David W. Sawyer,* research engineer, Aluminum Company of America, New Kensington, Pa. (51—SA-3)

The Hydrodynamic Lubrication of Sector-Shaped Pads, by *Ronald S. Brand,* assistant professor of mechanical engineering, University of Connecticut, Storrs, Conn. (51—SA-6)

The Nonsteady-State Load Supporting Capacity of Fluid Wedge Shaped Films, by *Ernest K. Gatcombe,* associate professor of mechanical engineering, U. S. Naval Postgraduate School, Annapolis, Md. (51—SA-5)

9:30 a.m.

Fuels (II)—Power (I)

Methods of Reducing Dust Emission From a Spreader-Stoker-Fired Boiler Furnace, by *W. C. Holton*, chemical engineer, and *Richard B. Engdahl*, supervisor, Battelle Memorial Institute, Columbus, Ohio. (51—SA-20)

9:30 a.m.

Heat Transfer (I)

A New Method for Determining the Static Temperature of High-Velocity Gas Streams, by *John A. Clark*, instructor of mechanical engineering, and *Warren M. Rohsenow*, assistant professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Heat Transfer and Pressure Drop Characteristics of Four Regenerative Heat Exchanger Matrices, by *A. Ambrosio*, *Clifford D. Coulbert*, junior engineer, department of engineering, *Robert P. Lipkis*, research assistant, engineering research department, *Philip F. O'Brien*, assistant engineer, department of engineering, and *Fred E. Romie*, research engineer, engineering department, University of California, Los Angeles, Calif.

9:30 a.m.

Aviation (II)—Gas Turbine Power (II)—IAS (I)

Turbojet Aircraft With Special Reference to the "Jetliner," by *E. H. Atkin*, chief engineer, A. V. Roe, Canada, Ltd., Toronto, Ont., Can. (51—SA-23)

Propeller Turbine Aircraft with Special Reference to the "Apollo," by *H. R. Watson*, chief designer, Sir W. G. Armstrong Whitworth Aircraft Company, Ltd., Baginton, Coventry, England. (51—SA-13)

The Mamba Engines in the "Apollo" Aircraft, by *B. H. Slatter*, head, experimental flight engineer, Armstrong Siddeley Motors Ltd., Parkside, Coventry, England. (51—SA-14)

9:30 a.m.

IIRD (I)

The Impact of Servomechanism Techniques on Instrumentation, by *Arthur Porter* head, research department, Ferranti Electric Ltd., Mount Dennis, Ont., Can. (51—SA-22)

On the Automatic Control of Generalized Passive Systems, by *Kun L. Chien*, *J. B. Reswick*, and *J. A. Hrones*, professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

12:15 p.m.

EIC-ASME Joint Luncheon

Presiding: *Col. Leroy Grant*, past-president, EIC, Toronto, Canada
Speaker: *Ira P. Macnab*, general manager, Halifax Public Service Commission, Halifax, Nova Scotia, Canada

2:30 p.m.

Railroad (I)—Fuels (III)

Air Pollution and Smoke Abatement, by *Owen R. Barefoot*, superintendent, motive power and car department, Canadian Pacific Railway Company, Toronto, Ont., Can.

Symposium on Performance Experienced with Double-Screened Locomotive Fuels

E. C. Payne, consulting engineer, Pittsburgh Consolidation Coal Company, Inc., Pittsburgh, Pa.
W. O. Cottingham, supervisor, locomotive performance, Western Maryland Railway Company, Hagerstown, Md.
H. G. Pike, superintendent of equipment, Pittsburgh and Lake Erie Railroad Company, McKees Rocks, Pa.
J. S. Swan, fuel conservation engineer, Louisville and Nashville Railroad Company, Louisville, Ky.
R. M. Pilcher, assistant engineer of tests, Norfolk and Western Railway Company, Roanoke, Va.

2:30 p.m.

Power (II)—IIRD (II)

Symposium on Centralized Control and Small Gauges

Modern Methods and Equipment for Control of Steam Generators, by *P. S. Dickey*, vice-president, Bailey Meter Company, Cleveland, Ohio

Electronic Combustion Control, by *Charles Smoot*, chief development engineer, Republic Flow Meters Company, Chicago, Ill.

Considerations in the Use of Smaller Instruments and Their Relation to Centralized Control, by *Theron W. Jenkins, Jr.*, field engineer, technical sales department, Leeds & Northrup Company, Philadelphia, Pa.

Centralized Control of Steam Electric Generating Stations, by *Melvin D. Engle*, mechanical engineer, head, mechanical-engineering department, and *H. F. Hatfield*, mechanical research engineer, Pennsylvania Power & Light Company, Allentown, Pa.

Remote Operation Through Centralized Control Rooms—A New Concept Developed on A.G. & E. System, by *Theodore T. Frankenberg*, American Gas and Electric Service Company, New York, N. Y.

Operating Experience With Centralized Control, by *Ralph B. Gutekunst*, efficiency engineer, Generating Stations, Commonwealth Edison Company, Chicago, Ill.

2:30 p.m.

Heat Transfer (II)

Further Remarks on Intermittent Heating for Aircraft Ice Protection, by *Frederick R. Weiner*, research assistant, University of California, Los Angeles, Calif.

A New Method of Determining Thermal Diffusivity of Solids at Various Temperatures, by *D. Rosenthal* and *A. Ambrosio*, University of California, Los Angeles, Calif.

2:30 p.m.

Aviation (III)—Gas Turbine Power (III)—IAS (II)

Technical Problems of Turbojet Transports With Special Reference to the "Comet," by *W. G. Townley*, general manager of operations, Canadian Pacific Airlines, Ltd., Vancouver, B. C., Can. (51—SA-15)

The Flying Boat With Special Reference to the "Princess," by *Henry Knowler*, chief designer, Saunders-Roe, Ltd., Osborne, East Cowes, Isle of Wight, England. (51—SA-7)

6:15 p.m.

Reception

ASME National Nominations

THE 1951 Nominating Committee is to meet for two days, June 11-12, 1951, at the Hotel Royal York in Toronto, Ont., Can., where the Semi-Annual Meeting will be held. Members are invited to appear at its scheduled open meetings on June 11 and June 12, 1951, where they may present their views concerning candidates for the office of President, Regional Vice-President, and Director at Large any time between the hours of 10:30 a.m. to noon, and 2 p.m. to 5 p.m. on Monday, June 11, and 9:30 a.m. to noon on Tuesday, June 12. Following the close of business of the 1951 Nominating Committee there will be held an Organization Meeting of the 1952 Committee presided over by the Chairman, Prof. Venton L. Doughtie, of the 1951 Committee. This will take place either on Tuesday afternoon, June 12, or Wednesday morning, June 13.

7:00 p.m.

Banquet

Toastmaster: The President, J. Calvin Brown
Speaker: Right Honorable C. D. Howe, Minister of Department of Defense Production, Ottawa, Ont., Can.

THURSDAY, JUNE 14

9:30 a.m.

Railroad (II)

Recent Developments in Oil Burning on Steam Locomotives, by *W. A. Vanderland*, junior engineer, Canadian Pacific Railway Company, Montreal, Que., Can.

Development Potentialities of the Alberta Oil Fields, by *O. B. Hopkins*, vice-president, Imperial Oil Limited, Toronto, Ont., Can.

9:30 a.m.

Power (III)—IIRD (III)

Supervisory Instruments for Power-Generating Equipment, by *E. Y. Stewart*, development engineer, and *J. H. Reynolds*, General Electric Company, Schenectady, N. Y.

Field Inspection of Boiler Tubes With Ultrasonic Reflectoscope, by *J. A. Tash*, chief chemist, Duquesne Light Company, Pittsburgh, Pa.

9:30 a.m.

Machine Design (II)—Aviation (IV)

Aircraft Turbosupercharger Bearings, Their History, Design, and Application Techniques, by *Samuel R. Puffer*, Aircraft Gas Turbine Engineering Division, General Electric Company, West Lynn, Mass. (51—SA-12)

The Fatigue Strength of Threaded Connections, by *Richard C. A. Thurston*, metallurgical engineer, Physical Metallurgy Division, Bureau of Mines, Ottawa, Ont., Can. (51—SA-11)

9:30 a.m.

Rubber and Plastics (I)

Engineering Properties of the Silicone Rubbers, by *P. C. Servais*, manager, silastic section, Product Engineering Laboratories, Dow Corning Corporation, Midland, Mich.

Synthetic Elastomers for Use at Low Temperatures, by *S. C. Einhorn* and *N. R. Legge*, Research Division, Polymer Corporation Ltd., Sarnia, Ont., Can.

Neoprene Applications in Engineering Design, by *Richard W. Malcolmson*, sales engineer, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del.

9:30 a.m.

Gas Turbine Power (IV)

Metallurgical Aspects of Gas Turbines, by *H. V. Kinsey*, metallurgical engineer, Physical-Metallurgy Division, Canadian Department of Mines and Technical Surveys, Ottawa, Ont., Can.

A Coal-Burning Gas Turbine, by *D. L. Mordell*, associate professor of mechanical engineering, and director, Gas Dynamics Laboratory, McGill University, Montreal, Que., Can.

A Theoretical and Mathematical Investigation of Vibrations of Nonuniform Cantilevers, by *H. P. Koehler* and *G. E. Anderson*, development engineer and metallurgist, A. V. Roe, Canada, Ltd., Toronto, Ont., Can.

2:30 p.m.

Railroad (III)

Development of the Opposed-Piston Diesel Engine, by *George A. Mueller*, general sales manager, Canadian Locomotive Company, Ltd., Montreal, Que., Can.

Power to Stop, (Motion Picture), by *R. B. Cottrell*, chief mechanical engineer, American Steel Foundries, Chicago, Ill. (51—SA-25)

2:30 p.m.

Power (IV)

Marine Engineering in Canada, by *A. C. M. Davy*, Commodore (E) OBE, RCN, Royal Canadian Navy, Department of National Defense, Ottawa, Ont., Can.

Geared Turbine Repowering of Great Lakes Vessels by *Bernard E. Ericson* Pittsburgh Steamship Company, and *F. H. Van Nest*, assistant engineer, Turbine Engineering Division, Lynn Works, General Electric Company, Lynn, Mass.

The Reboilering of the "Homer D. Williams," by *George J. Kirschner*, sales engineer, Foster Wheeler Corporation, New York, N. Y.

Some Developments in Marine Boiler Design, *S. F. Mumford*, chief engineer, marine department, Combustion Engineering-Superheater, Inc., New York, N. Y.

2:30 p.m.

Machine Design (III)

Competing With Nature's Hand, by *C. A. McLaurin*, research engineer, prosthetic services, Department of Veteran Affairs, Sunnybrook Hospital, Toronto, Ont., Can. (51—SA-17)

Design of a Semiautomatic Gaging and Sorting Machine, by *George M. Foster*, assistant superintendent, Manufacturing Engineering, Northern Electric, Ltd., Montreal, Que., Can. (51—SA-21)

2:30 p.m.

Rubber and Plastics (II)

Electric Control of Air-Flow Porosity in Plastic-Sheet Materials, by *J. J. Suran*, research and development engineer, John W. Meaker and Company, New York, N. Y. (51—SA-2)

Effect of Orientation on the Mechanical Properties of Polystyrene, by *Albert G. H. Dietz*, professor of structural engineering, and *Robert G. Cheatham*, research assistant, Massashusetts Institute of Technology, Cambridge, Mass.

The Effect of Absorbed Water on the Physical Properties of Phenolic Plastics, by *H. M. Quackenbos, Jr.*, and *J. M. Hill*, Bakelite Division-Union Carbide and Carbon Corp., Bound Brook, N. J.

2:30 p.m.

IIRD (IV)

Dynamic Force Reactions in Double-Ported Control Valves, by *C. F. King*, director of research, and *G. F. Brockett*, Fisher Governor Company, Marshalltown, Iowa. (51—SA-1)

Metastable Flow of Saturated Water, by *Joel F. Bailey*, assistant professor, department of mechanical engineering, University of Tennessee, Knoxville, Tenn.

ASME OGP Division to Meet in Dallas, Texas, June 25–29

THE 23rd annual conference and exhibit of the Oil and Gas Power Division of The American Society of Mechanical Engineers will be held at The Baker Hotel, Dallas, Texas, June 25–29, 1951. The Baker Hotel is completely air-conditioned and was selected with the comfort of delegates in mind.

A feature of the conference will be the special lecture course on Fundamentals and Practical Aspects of Engine Governing. The morning lecture will be given by Forrest Drake of the Woodward Governor Company, Rockford Ill. The afternoon lecture will be by M. N. Halberg, General Electric Company, Schenectady, N. Y.

No fee will be charged for the lectures but in accordance with past procedure, a nominal registration fee will be charged for the conference. This will entitle members to receive copies of papers and to attend all technical sessions.

Diesel Exhibits

Every year the Oil and Gas Power Division arranges with selected manufacturers to display their products which are of interest to members of the Division. Year after year these exhibits have increased the benefit and pleasure to be derived from attendance. This year some 30 exhibitors will be represented. At this exhibit members can expect to learn what is new in the way of Diesel engines and auxiliaries.

Friday of the conference is being set aside for a 12-hour field trip to two widely scattered Texas industrial plants utilizing internal combustion using Diesel engines. The inspection party will leave Dallas on a regular scheduled airliner for Corpus Christi, Texas, a distance of about 500 miles. There a two-hour inspection trip will be made of the Halliburton Cement Works. Of interest will be an 8000-hp Diesel installation and the manufacture of cement from sea shells.

The party will then fly to Victoria, Texas, a distance of 100 miles, where they will embark on buses for the Point Comfort Plant of the Aluminum Company of America, where they will inspect one of the largest installations in the world of internal-combustion engines.

In concept, in the number of miles traveled, in the size and novel application of the internal-combustion engines to be viewed, this tour is unique in recent ASME history. It offers an experience that members may not have an opportunity to duplicate for many years. Members who plan to attend the conference and to participate in the tour, should write to Oil and Gas Power Division, The ASME, 29 West 39th Street, New York 18, N. Y., for particulars.

C. A. Besio, assistant professor of mechanical engineering, Southern Methodist University, Dallas, Texas, and past-president of the South Texas Section, is chairman of the general arrangements committee of the conference.

The technical program follows:

MONDAY, JUNE 25

8:30 a.m.

Registration

10:30 a.m.

Technical Session

Effect of Charge Temperature and Pressure Upon the Rating of Diesels, by *Ralph Miller*, chief engineer, Cycle Division, Nordberg Manufacturing Company, Milwaukee, Wis.

12:00 noon

Welcome Luncheon

2:00 p.m.

Technical Session

Damage Prevention From Diesel Engine Crankcase Explosions, by *Albert C. Cavileer*, head of large Diesel engines branch, Internal Combustion Engine Laboratory, U. S. Naval Engineering Experiment Station, Annapolis, Md.

Crankcase Explosions, by *G. W. Ferguson*, The Texas Company, New York, N. Y., and *Brian Corrigan*, mechanical engineer, Technical and Research Division, The Texas Company, New York, N. Y.

TUESDAY, JUNE 26

Special Lectures on Fundamentals and Practical Aspects of Engine Governing.

9:30 a.m.

Lecture by *Forrest Drake*, Woodward Governor Company, Rockford, Ill.

2:00 p.m.

Lecture by *M. N. Halberg*, General Electric Company

8:00 p.m.

WEDNESDAY, JUNE 27

9:30 a.m.

Operators' Panel

Moderator: *Harry L. Kent, Jr.*, associate professor of mechanical engineering, University of Texas, Austin, Texas

2:00 p.m.

Chief Engineers' Panel

Moderator: *George Steven*, executive engineer, Worthington Pump & Machinery Corporation

7:00 p.m.

Banquet

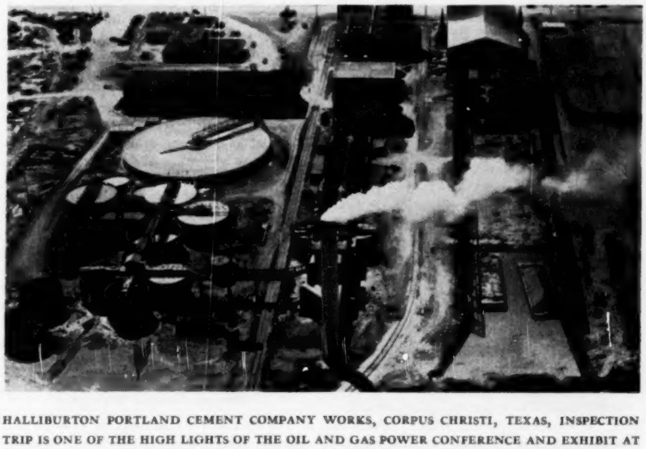
Toastmaster: *Otto H. Fischer*, president, Union Diesel Engine Company, Oakland, Calif.

THURSDAY, JUNE 28

9:30 a.m.

Technical Session

Modern Gas Engines, by *Ralph L. Boyer*, vice-president and chief engineer, and *W. R. Crooks*,



HALLIBURTON PORTLAND CEMENT COMPANY WORKS, CORPUS CHRISTI, TEXAS, INSPECTION TRIP IS ONE OF THE HIGH LIGHTS OF THE OIL AND GAS POWER CONFERENCE AND EXHIBIT AT THE BAKER HOTEL, DALLAS, TEXAS, JUNE 25–29, 1951

resident engineer, Cooper-Bessemer Corporation, Mount Vernon, Ohio

Operation of a Direct-Connected Engine-Driven Compressor as a Gas Generator, by *John N. MacKendrick,* vice-president, *George Bollman,* project engineer, and *C. A. Chamberlain,* project engineer, Clark Brothers Company, Inc., Olean, N. Y.

2:00 p.m.

Technical Session

Design of Exhaust Snubber for the Gas Engine, by *R. L. Leadbetter,* vice-president, Burgess-Manning Company, Chicago, Ill.

Performance and Operation of Water-Cooling Equipment, by Howard E. Degler, technical director, The Marley Company, Kansas City, Kan.

FRIDAY, JUNE 29

7:00 a.m.

Field inspection trip via airplane to Halliburton Portland Cement Company, Corpus Christi, Texas, and Aluminum Company of America, Point Comfort, Texas

9:00 a.m.

Other field inspection trips

ASME to Cosponsor Session at Wood Industries Conference

THE Wood Industries Division of The American Society of Mechanical Engineers is cosponsoring a technical session at the Fifth Annual Meeting of the Forest Products Research Society to be held in Convention Hall, Philadelphia, Pa., May 7–13, 1951.

The theme of the ASME session will be "New Machinery, Machining, and Production Methods." E. Sigurd Johnson, associate professor, North Carolina State College, Raleigh, N. C., will preside.

Eight technical societies and associations working with the wood industries will also cosponsor sessions. The general theme of the Forest Products Research Society meeting will be "Wood Mobilization Requirements in Machines, Products, and Processes."

The program represents a co-operative effort to make available the latest technical information useful to the wood industries. Papers selected for the program were those judged useful to members of the wood industries confronted with problems arising from current need for expansion of production to meet national defense demands.

Other participating organizations in the program include: American Paper & Pulp Association, American Society for Testing Materials, American Wood Preservers Association, Association of Manufacturers of Woodworking Machinery, Northeastern Wood Utilization Council, Society of American Foresters, and Society of the Plastics Industry. A number of experts from the Armed Forces are also contributing to develop a timely and vital technical program.

The ASME-sponsored session will be on Wednesday morning, May 9. The following papers will be presented:

Some Aspects of Wood Machining Studies, by L. A. Patronsky, Mem. ASME, School of Natural Resources, University of Michigan, Ann Arbor, Mich.

Where and How to Use and Maintain Carbide Cutting Tools in the Wood Industries, by Don Flinchbaugh, Redco Tool Division, Red Lion Cabinet Company, Red Lion, Pa.

Other papers of interest to ASME members will be:

Quality Control in Lumber Manufacture, by Dr. J. S. Bethel, A. C. Barefoot, and Donald Stecher, School of Forestry, North Carolina State College, Raleigh, N. C. (Mon., May 7.)

Effect of the Defense Program on the Availability of Woodworking Equipment, by Ray C. DuBrucq, vice-president, Crescent Machine Division, Rockwell Manufacturing Company, and president, Association of Manufacturers of Woodworking Machinery, Washington, D. C. (Tues., May 8.)

Mobilization Requirements for Technical Men in the Wood Industries, by C. D. Dosker, president, Gamble Brothers, Inc., Louisville, Ky. (Tues., May 8.)

Comments Sought on ASME Special Lecture Program

THE Board on Technology of The American Society of Mechanical Engineers has before it the question of whether the Society should continue its program of special lectures initiated in 1944, to provide ASME Sections with eminent speakers on engineering subjects.

During the first year of the program, Lionel S. Marks, Fellow ASME, professor emeritus, Harvard University, Cambridge, Mass., and Stephen P. Timoshenko, Fellow ASME, professor, theoretical and applied mechanics, Stanford University, Stanford, Calif., visited Sections in the East and South. Dr. Marks' subject was "Jet Propulsion and Rockets." Dr. Timoshenko talked on "Stress Concentration and Fatigue Failures." Other ASME lecturers were Lillian M. Gilbreth, Fellow ASME, president, Gilbreth Inc., Montclair, N. J., on "The Engineer's Part in Solving Today's Management Problems"; W. Trinks, Fellow ASME, partner, Associated Engineers, Pittsburgh, Pa., on "Recent Work in Forging Research"; and Dexter S. Kimball, Fellow and Honorary Member ASME, Ithaca, N. Y., on "Can Democracy Survive in a Mechanized Society?"

In many sections these lectures were eminently successful, some attracting audiences of 1200.

Members who recall these lectures are asked to submit their comments and suggestions to Crosby Field, ASME Board on Technology, 29 West 39th Street, New York, N. Y.

Southern Prosperity and Economic Opportunity Keynote of ASME Spring Meeting

700 Attend Four-Day Meeting in Atlanta

BRIGHT new industrial plants standing in fields already broken for additional construction and the energy and confidence of Southern engineers fully aware of the tremendous potential of Southern agriculture and industry were two observations which impressed members and guests who attended the 1951 Spring Meeting of The American Society of Mechanical Engineers held in Atlanta, Ga., April 2–5, 1951. What could be seen and heard amply substantiated statements made by many speakers that the South was indeed the land of economic opportunity, particularly for engineers prepared to contribute to an expanding economy still in its initial stages.

Some 700 members, student members, and guests took advantage of a program of technical sessions, plant trips, and many social events. Officers of Region IV met throughout Sunday to consider the agenda of the National Delegates Conference to be held at the Semi-Annual Meeting at Toronto, Ont., Can., and to discuss regional administration problems. Conspicuous during the first two days of the meeting was the large number of student members from engineering schools of the Southeast who were in Atlanta for the Region IV Student Branch Conference, held concurrently with the Spring Meeting.

Officials Extend Welcome

The President's Luncheon on Monday was the first general event of the Spring Meeting. Some 400 members, student members, and guests were present to hear William B. Hartsfield, Mayor of Atlanta, and Herman E. Talmadge, Governor of Georgia, extend a welcome to the ASME. Paul H. Nichols, chairman, ASME Atlanta Section, presided.

Because of its strategic position, Atlanta was the regional capital of the Southeast, Mayor Hartsfield said. A crossroads for rail and air transportation, the city was also the center of distribution, with most national manufacturers having branch offices in the city.

MR. AND MRS. PAUL H. NICHOLS AT THE BANQUET. MR. NICHOLS IS CHAIRMAN OF THE ASME ATLANTA SECTION

Endowed with the three things necessary for a prosperous city—a favorable climate, an energetic people, and an abundant water supply—Atlanta has tried to control its growth along sound engineering principles. It anticipated wartime expansion of industry by enlarging its water supply which can be developed to provide for population of a million residents. To prevent a decay of the center of population, Atlanta is taking steps to enlarge the city limits so as to absorb the growing suburbs.

Touching on the devastation suffered during the invasion, Mr. Hartfield related how the city had been rebuilt without a sense of bitterness. Men from all sections of the country are serving in the city government. All are welcomed to participate in the prosperity of the South, he concluded.

Governor Talmadge paid tribute to engineers as those most responsible for the American way of life. The South, he said, has been undergoing an economic revolution during the last two decades. As the largest state east of the Mississippi, Georgia has been rapidly developing its agriculture. The old cotton economy has given way to grazing, dairying, and poultry farming, well suited to Georgia's climate and geography. The state was currently balancing its agriculture with industry. Industrial leaders have told him, Governor Talmadge said, that their Georgia plants were serving as yardsticks for performance of older plants situated in other sections. The South, so recently characterized as an economic problem, is now a region of "economic opportunity."

Engineering Manpower

As the main speaker, Pres. J. Calvin Brown warned that the nation was facing a critical shortage of engineers created by the Korean situation, the interruption of the flow of engineering graduates during the last war, and the continuing expansion of American economy and production facilities. To help solve this shortage, the Engineers Joint Council organized an Engineering Manpower Commission to work for most effective utilization of available engineers and to insure a steady flow of engineers from engineering schools.

President Brown called on management to raise engineering salaries to prevent the profession from losing "some of the best minds" to other callings. He asked every engineer to support the program of the EJC Engineering Manpower Commission.

"Your support can be evidenced in several concrete ways," he said. "For example, you can seek out in your communities boys with an aptitude for engineering and encourage them to consider engineering as a career.

"Those of you who have managerial responsibilities in industry should give serious thought to the problem of emphasizing the material rewards of engineering. Some way ought to be found to increase the economic differential between engineering and the crafts.

"If you are called into the service, endeavor to be assigned to engineering work. Warfare is still a business of men, materials, and methods. Effective utilization of engineers in uniform will relieve the pressure on engineers in industry. What happens to you in the Armed Forces must be your prime concern. You can accept with resignation any task assigned or you can make your training known to your superiors and request an engineering assignment. You can write to your society or to the EJC Engineering Manpower Commission."

AT THE TEXTILE LUNCHEON

(*Left to right:* Lindsay Dexter, R. O. Palmer, Norman E. Elsas, M. E. Heard.

AT THE TEXTILE SESSION ON WEDNESDAY AFTERNOON

(*Left to right:* W. C. Bliss, R. S. Curley, J. A. Skelton, and Peter M. Strang.)

In conclusion he said, "I have a final word for the young graduate. The path to professional development is just as broad and as rich in opportunities when it leads into the Armed Forces as when it leads into industry. The uniform is not a camouflage of the mind. You are as much an engineer in uniform as out.

Hold on to your pride in your profession and endeavor to become assigned as soon as possible to work of an engineering nature."

Roy V. Wright Lecture

Frank H. Neely, chairman of the board of Rich's Inc., and of the Federal Reserve Bank of Atlanta, delivered the second Roy V. Wright Lecture on Monday. Mr. Neely accused American professional and business leaders of a lack of public-mindedness and failure to exert influence on men in public office for the good of the community.

The Roy V. Wright Lecture was established in 1949 and was named for the late Mr. Wright, ASME president in 1931, as a tribute to his activities in impressing on engineers and young people the duties and privileges of citizenship in a democracy.

Mr. Neely said the engineer's "innate ability to go straight to the heart of a problem" makes him invaluable in our "ever-growing, complicated democracy."

"Indeed," he declared, "straight thinking at all levels of government, and the expenditure of the substance of the population in the form of tax money is a major question in the maintenance and the development of our country. In these fields the engineer must serve directly, either as a career, or indirectly, as a volunteer in limited areas. We must help to maintain a simplicity and economy that will enable our government, with its multitude of services to the people, to balance the costs against the necessities of human existence.

"Our allegiance needs no encouragement in time of war; the emotions fan courage and sacrifice; but when that necessity passes, when immediate emergency declines, when danger is over, we take our government for granted; we do not concern ourselves with its functions, and we lapse into civic inactivity."

Mr. Neely called for a widening of the engineering curriculum to equip students with the knowledge and perspective to discharge their responsibilities as citizens.

"History, languages, and social sciences have received the brush-off in favor of the concentrated engineering studies," he declared. "But for the better use of engineering knowledge, a more comprehensive education ought to be offered, providing a background for the pure technical training.

"The engineer at the time of graduation walks out into the world as ignorant of what makes its wheels go round as he is knowledgeable of what causes technical motion. He has not learned the relationships among the technical professions as a whole. The relationships of professional, business, and governmental functions, the elements by which the democracy operates, are unknown to him."

"Equipped with all the technical knowledge he can digest," Mr. Neely said, "the engineering graduate goes out into the world, not only with small knowledge of the structure of the community, but with little or no knowledge of how to get along with people responsible for the maintenance of that structure.

"So it would behoove the college to give him also an appreciation of the people who guide the various organizations for the state, their besetting problems, and the various methods by which they may be helped by laymen," declared Mr. Neely.

COL. FRANK F. GROSECLOSE ADDRESSING MANAGEMENT LUNCHEON

Engineers Needed in Textile Industry

The Textile Luncheon on Tuesday was one of the high lights of the textile program at the Spring Meeting, which included two technical sessions and a visit to the Hightower Textile Engineering Building of the Georgia Institute of Technology. More than 100 members and guests of the Division listened to M. E. Heard, vice-president in charge of research, West Point Manufacturing Company, Shawmut, Ala., speak on "The Engineer in the Textile Industry." Norman E. Elsas, president, Fulton Bag and Cotton Mills, Atlanta, Ga., presided.

The textile industry offers a golden opportunity to engineers because it is currently emerging from the period of empiricism which has prevailed since the eighteenth century when the industrial revolution changed textile manufacturing from a cottage into a mass-production industry, Mr. Heard declared. A remarkable job has been done, he continued, in meeting world demand for textiles, but past performance will not be good enough in the future. Empiricism must give way to judgment based on facts. The industry must turn to engineers, men who by profession are trained in fact finding and the application of facts, if it is to survive the challenge of new methods and materials.

Engineers are needed, he said, to advise management of textile mills on purchases of new equipment. American machine manufacturers are constantly offering the industry new and better processing machinery. When as many as fifteen manufacturers offer a different and competing model of a cost-cutting machine the manufacturer is confronted with a difficult choice calling for the services of a competent mechanical engineer. The industry needs its own engineers in the selection of new equipment, Mr. Heard said.

The industry too was becoming critical of its own management techniques and was seeking methods to improve operations. Symptomatic of the old days was the practice of maintaining a force of "spare hands" which were productive only at peak periods. While the industry was financially sound, it would not be able to support unproductive workers in the future. The job of production control, of adapting new techniques to traditional processes should fall more and more to men specially trained in new concepts of management.

The textile industry, Mr. Heard declared, was currently going through an "evolution of education." One of the most important services the engineer could render was to "lead and direct" that education at a proper pace so that new methods could be absorbed on all levels within the industry. The traditional empiric methods would give way only slowly. Each new step must be appreciated before it would be accepted, he warned.

Many engineers were already in the industry. More were needed. In addition to "grand opportunity" in an industry which is ripe for engineering skills, these men enjoy a "continuity of employment that is rarely matched by any other industry in the country, he concluded.

Statistics Show Expanding Economy

Statistics on the expanding economy of the South were presented to the audience attending the Management Luncheon on Wednesday by Col. Frank F. Groseclose, director of the School of Industrial Engineering of Georgia Institute of Technology.

PRES. J. CALVIN BROWN PRESENTS CERTIFICATE OF FELLOW TO COL. BLAKE R. VAN LEER

Once termed the country's biggest economic headache, the South now showed greater increases percentagewise in the value of manufactured products, value added by manufacture, and per capita income during the past ten years than the United States as a whole, while the increase in actual annual expendable income in the South since 1940 was 357 per cent, the greatest in the history of the nation, Colonel Groseclose stated.

It was only the beginning of what the South could do with the labor, natural resources, markets, and power facilities at its command, he added.

In the past decade the value of manufactured products increased 248 per cent in the South as compared with 232 per cent for the whole nation. The value added by manufacture increased 176 per cent in the South against 157 per cent for the United States, he continued.

A study of the most recent census of manufacturers indicates that an average of seven new industrial plants opened for business in the South on every working day for the last ten years, and "for every one million dollars which went into new corporations and concerns in the South, 15 million dollars went into the expansion of industries already established here," he declared.

Southern income, although still less per capita than in the nation as a whole, rose 180 per cent between 1940 and 1947, while the entire United States income rose 150 per cent, said the Colonel.

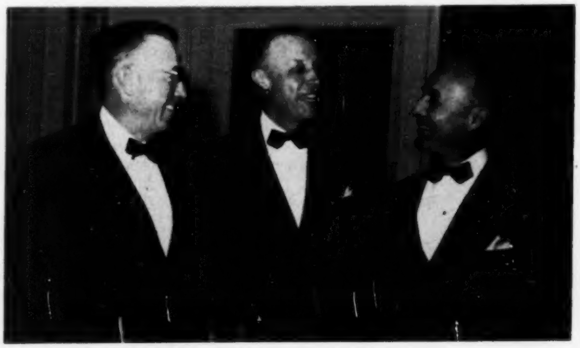
Since 1940 the gain in cash farm income for the nation has been 233 per cent, while for the South it has been 272 per cent. Colonel Groseclose said the South comprises approximately one third of the national land area, about one third of the population, and one third of the labor force. The region is made up of the following 16 states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia.

Fifth of Manufactured Goods Produced

In the manufacture of goods the South is producing only one fifth of the national total, but there are certain types of manufacturing which excel there, he declared. These types naturally are related pretty closely to our raw products—which is certainly good business. In spite of the enormous lead in textile manufacturing formerly held by the North, the South is now doing nearly 60 per cent of all textile manufacturing. In tobacco manufacturing, three quarters of the national total is done in the South.

Chemical manufacturing has passed the $33^1/_3$ per cent mark, and for petroleum coal products, manufacture in the South has passed the 40 per cent mark. These 16 Southern states are also doing a little more than their share of lumber manufacture and a reasonable share of nearly everything.

In the field of distribution, he said, the income from all utilities was about one third of the national total during the past decade, and the income from rail, highway, air, and water transportation was more than one third of the national total. The South stands alone as the source of many raw materials, he declared.



EUGENE W. O'BRIEN, HONORARY CHAIRMAN, WITH WILLIAM H. RUFFIN, PRESIDENT, NATIONAL ASSOCIATION OF MANUFACTURERS; AND PRES. J. CALVIN BROWN

Col. Blake R. Van Leer Honored

The social program of the meeting was concluded with a banquet on Wednesday which was addressed by William H. Ruffin, president, National Association of Manufacturers, and president of Erwin Mills, Inc., Durham, N. C. His subject was "Pulling Together for the Long Pull." Eugene W. O'Brien, past-president ASME, presided.

The speakers' table, resplendent with spring flowers so abundant in Atlanta, formed a beautiful setting for honoring one of Atlanta's outstanding leaders, Col. Blake R. Van Leer, president, Georgia Institute of Technology. The honor, an elevation to the Fellow grade of ASME membership, was announced as a surprise by President Brown. He asked Colonel Van Leer to come forward to receive a framed certificate of Fellowship. (For a biographical sketch of Colonel Van Leer, see page 447.)

Before Mr. Ruffin was introduced, a double quartet composed of Georgia Tech students entertained the audience with renditions of their lusty school song and some sentimental songs appropriate to the season.

Inflation Endangers Defense Program

Mr. Ruffin called attention to the seriousness of the international situation and suggested five steps essential to the preservation of the American way of life. If America does not win the war on inflation, he said, there would be no use "thinking or talking about military victories." The national defense program upon which the nation is embarked must give us "maximum strength for the long haul," prepare us for full mobilization if and when required, and it must guard the health, living standards, and long-term welfare of the people.

Such a program required five essential steps, which he enumerated as follows:

1 Priorities and allocations should be used to assure the steady flow of materials needed for the military program.

2 The private credit system, involving commercial banks, installment credit, and other forms of credit, must be prevented from adding to inflation. This means that the Federal Reserve must again take control of the money and credit system, using the interest rate and its other powers to restrict credit to loans which will not feed inflation.

3 The total cost of the military program, as well as government expenditures, must be covered by taxes.

4 Government expenditures not essential to national defense must be reduced to the minimum. Every dollar saved by elimination of nonessential government spending is doubly valuable—it eases the tax burden and can be applied to the pay-as-we-go tax policy we must have to stop inflation.

5 Taxes imposed to cover expenditures must curtail spending, not savings and investments.

"Inflation is the 'sixth column' by which international Communism hopes to take us over in a bloodless coup d'etat," Mr. Ruffin said. "Inflation can not only defeat our best efforts to produce. It can bring us to economic and moral disaster as quickly and more surely than any physical enemy we shall ever face."

"Direct controls are not the answer, as was proved conclusively during World War II," he explained. "Controls reach only the symptoms of inflation—they do not touch the cause. The price and wage controls of World War II did not prevent inflation. What they did was to camouflage the results of deficit financing."

The American people are still paying the inflated price of deficit financing, in 56-cent dollars, Mr. Ruffin pointed out.

"To loan on the economic precedents of the last war, to expect maximum effective defense to result from more and bigger controls is to court disaster," Mr. Ruffin warned.

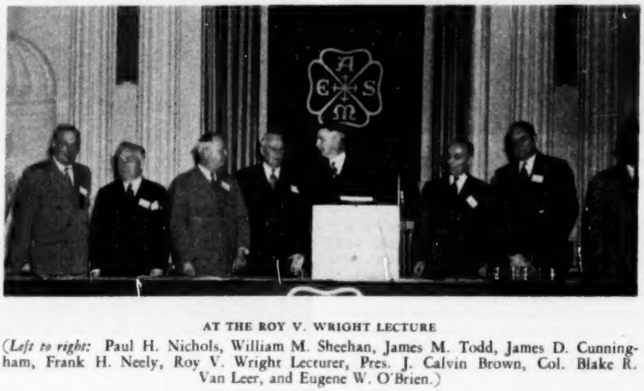
THE PRESIDENT'S LUNCHEON AT THE 1951 ASME SPRING MEETING

(*Left to right:* Herman E. Talmadge, Governor of Georgia; Pres. J. Calvin Brown, ASME Eugene W. O'Brien, honorary chairman, Spring Meeting; Paul H. Nichols, chairman, Atlanta Section; and William B. Hartsfield, Mayor of Atlanta.)

Technical Program

The technical program consisted of 21 sessions at which 48 papers were presented. Among the high lights of the program was the session on dual-fuel firing at which design of multifuel burners and the use of oil and gas in stoker-equipped furnaces were discussed. In a symposium on cooling towers, seven papers were presented on the economic aspects of design, selection, operation, and maintenance of cooling equipment; operating experiences with cooling towers in the Central Gulf area, and the deterioration of wood in cooling towers. Considerable interest was shown in utilization of waste fuels in a special joint session sponsored by the Fuels and Power Division, which covered storage, handling, and burning of dry wood waste and developments in spreader firing of wet wood.

A paper which received considerable local attention from the press was one by S. Stokes Tomlin, Jr., which discussed how materials-handling techniques can reduce cost of distribution to customers. Analysis of accident-cause data was the subject of another interesting session sponsored by the ASME Safety Committee and the American Society of Safety Engineers. Following a discussion of case histories, a panel of four speakers presented the point of view of an industrial super-



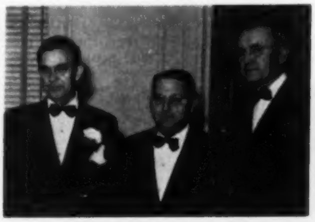
AT THE ROY V. WRIGHT LECTURE

(*Left to right:* Paul H. Nichols, William M. Sheehan, James M. Todd, James D. Cunningham, Frank H. Neely, Roy V. Wright Lecturer, Pres. J. Calvin Brown, Col. Blake R. Van Leer, and Eugene W. O'Brien.)

VICE-PRES. STEPHEN D. MOXLEY AMONG FRIENDS

(*Front row:* Mrs. Claude L. Huey and Mrs. Leslie F. Zsuffa. *Back row:* Mr. Zsuffa, Vice-President Moxley, and Mr. Huey.)

MARIO J. GOGLIA, CHAIRMAN OF THE TECHNICAL SESSIONS, MRS. GOGLIA, AND ROGER MARTIN DURING THE WEDNESDAY SOCIAL HOUR



A. M. DEITERS, STEPHEN D. MOXLEY, AND E. E. WILLAMS WERE AMONG THE HONORED GUESTS AT THE SPRING BANQUET

visor, industrial nurse, plant engineer, and job-training specialist.

For digests of ten of the Spring Meeting papers, see pages 427–431 of this issue. Other papers for which manuscripts were submitted will be digested in future issues of MECHANICAL ENGINEERING. For a complete list of papers presented, members are referred to the program published in the March issue, pages 268–270. Pamphlet copies of many of these papers may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Until the supply is exhausted, cost per copy will be 25 cents to members and 50 cents to nonmembers.

Student Conference

The 1951 Region IV Student Branch Conference was held on Monday, the first day of the Spring Meeting. The program consisted of two technical sessions at which 12 speakers competed for five prizes. On Monday, the students attended the President's Luncheon and heard Pres. J. Calvin Brown offer advice to young engineers about to be called into the Armed Forces. In the evening the students attended a banquet at Brittain Dining Hall of the Georgia Institute of Technology, at which the following winners of the papers' competition received prizes:

1st prize K. W. Whittington of the University of Florida, for his paper, "The Hydrocal—A Hydraulic Analogue."

2nd prize A. W. Jenkins of the University of Virginia, for his paper, "Pneumatic Ash Conveying."

3rd prize W. E. Durham of the Virginia Polytechnic Institute, for his paper, "The Unicel Boxcar."

4th prize J. F. Steedley of the Georgia Institute of Technology, for his paper, "Opportunity or Security."

5th prize D. Martin of Duke University, for his paper, "Ranque's Tube."

Following the dinner, student members enjoyed an informal dance in the gymnasium of the Georgia Institute of Technology.

Many of the students stayed over for the second-day program, which included the Junior Conference arranged by the National Junior Committee, at which B. P. Graves, consultant in design, Brown & Sharpe Manufacturing Company, Providence, R. I., discussed, "Machine Design as a Career in Industry." The second half of the conference was devoted to the topic "A Current Plan for Young Engineers." (For a report of the conference, see page 457.)

Inspection Trips

Four Atlanta industrial plants were hosts to ASME members during the meeting. On Monday more than 100 members and guests visited the Buick, Oldsmobile, and Pontiac Assembly Plant of the General Motors Corporation at Chamblee, Ga. This plant, set on

MEMBERS OF THE ATLANTA SECTION WHO ENJOYED THE MEETING

(*Left to right:* Roger L. Holmes, Jr., Mrs. Holmes, Mrs. William V. Bishop, and Mr. Bishop.)

PART OF THE AUDIENCE AT THE REGION IV STUDENT BRANCH COMPETITION

a 386-acre site, is an assembly unit for final production of Buick, Oldsmobile, and Pontiac cars.

On Tuesday afternoon members of the Textile Division visited the Hightower Textile Engineering Building of the Georgia Institute of Technology. The building, which was only recently completed, contains the latest equipment for weaving, manufacturing, and dyeing yarns and textiles.

Another trip was made to the Atlantic Steel Company in Atlanta.

Of interest also was an inspection of the East Point, Ga., Plant of the Southern Wood Preserving Company.

Women's Program

For wives of members an interesting program was arranged by the Woman's Auxiliary of the ASME Atlanta Section, beginning with the President's Luncheon on Monday and ending with the Spring Banquet on Wednesday. During the three days the women were entertained by Mrs. Blake R. Van Leer, at the President's home, Georgia Institute of Technology.

Committee

The following persons were in charge of arrangements for the Spring Meeting: *General,* Eugene W. O'Brien, honorary chairman; Leslie F. Zsuffa, co-chairman; Claude L. Huey, co-chairman; *Technical Events,* Mario J. Goglia, chairman; *Inspection Trips,* L. L. Pitts, chairman; *Printing and Signs,* Vincent F. Waters, chairman; *Hotel Arrangements,* Frank E. Markel, chairman; *Entertainment,* Roger A. Martin, chairman; *Registration and Tickets,* Robert F. Haller, chairman; *Publicity,* William V. Bishop, chairman; *Reception,* John H. Rittelmeyer, chairman; Finance, John A. Dodd, chairman; *Ladies,* Mrs. Paul H. Nichols.

Actions of the ASME Executive Committee

A MEETING of the Executive Committee of the Council was held in the Atlanta Biltmore Hotel, Atlanta, Ga., April 2, 1951. There were present: J. Calvin Brown, chairman; F. M. Gunby, vice-chairman; W. M. Sheehan of the Executive Committee; J. D. Cunningham, E. W. O'Brien, J. M. Todd, past-presidents; H. R. Kessler, S. D. Moxley, and J. C. Reed, vice-presidents; L. J. Cucullu, B. P. Graves, H. E. Martin, directors at large; C. E. Davies, secretary; Ernest Hartford, executive assistant secretary; and Forrest Nagler and Alex C. Ormond, guests.

Regional Boundaries

As a result of a study of Regional boundaries and policy on Sections and Subsections, a committee composed of F. M. Gunby, J. C. Reed, and S. H. Graf, recommended: (1) That regional boundaries continue as they now exist; (2) that the boundaries of Regions be restudied from time to time to permit recognition of changed conditions during the interim; (3) that the present policy on Sections and Subsections be continued and that units smaller than Sections be recognized only after they have been developed and show promise of growth; (4) that the determination of areas for territory of Sections and Subsections remain an administrative matter to be initiated by vice-presidents and action by Council.

Roy V. Wright Lecture

The appointment of C. J. Mackenzie, chairman, National Research Council, Ottawa, Canada, as the Roy V. Wright Lecturer at the Semi-Annual Meeting at Toronto was approved. A policy of having the Council or the Executive Committee approve selection of the Roy V. Wright Lecturer was adopted.

Certificate of Award

A certificate of award for Edward H. Walton, chairman of New Haven Section from 1947–1949 was approved.

American Rocket Society

A resolution extending the agreement between the ASME and the American Rocket Society for a period of five years was approved.

Edwin S. Carman

The death of Edwin S. Carman, president of the Society during 1920–1921, on March 20, 1951, was noted with regret.

You Can Afford the 1951 ASME Annual Meeting at Atlantic City

THE CHALFONTE-HADDON HALL, IN ATLANTIC CITY, WHERE THE ASME 1951 ANNUAL MEETING WILL BE HELD, NOV. 25–30, 1951

(The first ASME Annual Meeting held in Atlantic City in 1947 was so successful that a policy of holding a meeting outside of New York every four years was established. While the registration was lower, attendance at sessions was higher than at New York meetings. Plan now to come to Atlantic City in 1951. If you can afford New York you can afford Atlantic City. As a winter resort town there are many good hotels in the vicinity of the headquarters hotel. These offer accommodations at rates lower than in New York. Atlantic City is not much farther than New York for most members., The town abounds in good restaurants with prices to accommodate any budget. You can afford to come to Atlantic City for the 1951 Annual Meeting and see how pleasant and economical an Annual Meeting can be.)

Junior Forum

Region IV Juniors Sponsor Successful Conference at 1951 Spring Meeting

Machine Design and Professional Development Were Topics

EXPERIENCE and ambition met on the same level during the Junior Conference held during the 1951 Spring Meeting at Atlanta, Ga., and in an earnest three-hour discussion explored the gamut of what makes for personal growth in the engineering profession. While the discussions were paced by such leaders as Eugene W. O'Brien, past-president ASME, and B. P. Graves, director at large ASME, the main discussion was carried on by ten Junior delegates selected by the Sections in Region IV to come to the Spring Meeting at the expense of the Old Guard Committee.

An audience of some 100 members and guests, 75 per cent of whom were student members, looking forward to graduation in a few months, received an insight into the machine-tool industry and the opportunities it had to offer young engineers who wanted to learn from the bottom up. The Junior delegates, the majority of whom had less than ten years in industry, commented on the following factors which contribute to engineering success: Self analysis, objectives, fundamentals, practical experience, articulateness, loyalty to company, and cultivation of friendships.

ASME Calendar of Coming Events

June 11-15
ASME Semi-Annual Meeting, Hotel Royal York, Toronto, Ont., Can.
(Final date for submitting papers was Feb. 1, 1951)

June 22-23
ASME Applied Mechanics West Coast Conference, Stanford University, Stanford, Calif.
(Submit papers through J. N. Goodier, Division of Engineering Mechanics, Stanford University)

June 25-29
ASME Oil and Gas Power Division Conference Baker Hotel, Dallas, Texas
(Final date for submitting papers was Feb. 1, 1951)

Sept. 10-14
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Houston, Texas
(Final date for submitting papers was May 1, 1951)

Sept. 24-26
ASME Petroleum Mechanical Engineering conference, Hotel Mayo, Tulsa, Okla.
(Final date for submitting papers was May 1, 1951)

Sept. 25-28
ASME Fall Meeting, Hotel Radisson, Minneapolis, Minn.
(Final date for submitting papers was May 1, 1951)

Oct. 11-12
ASME Fuels and AIME Coal Divisions Joint Conference, Hotel Roanoke, Roanoke, Va.
(Final date for submitting papers—June 1, 1951)

Nov. 25-30
ASME Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
(Final date for submitting papers—July 1, 1951)
(For Meetings of Other Societies see page 445)

In the audience was F. D. Herbert, chairman of the Old Guard Committee of the ASME, which for the second year is spending its funds to enable selected Junior members to attend national meetings of the Society. The Committee is composed of dues-exempt members who continue to pay dues to a special fund used to aid younger engineers.

The Junior Conference idea was initiated by the National Junior Committee at the 1949 Annual Meeting as a means of bringing together student and Junior members for exchange of information on professional development. Conferences have been held in Washington, D. C.; St. Louis, Mo.; and Worcester, Mass. Others are planned for the Semi-Annual Meeting in Toronto, Ont., Can.; and at the 1951 Fall Meeting in Minneapolis, Minn. Sections in the ASME Region in which the conference is held are invited to appoint delegates whose transportation to and from the conference is covered by the Old Guard.

Junior Delegates

Region IV Junior delegates to the Spring Meeting were: Crawford S. Anderson, Jr., *Savannah Section;* Albert F. Bullock, *Birmingham;* C. A. Dewey, Jr., *Piedmont-North Carolina;* Herbert G. Duggan, *East Tennessee;* Leo A. Padis, *Virginia;* Robert Patton Sullivan, *Chattanooga;* E. J. Vann, *Greenville;* A. O. White, Jr., *Atlanta;* Leslie C. Wilbur, *Eastern North Carolina;* and Evert A. Young, *Florida.*

Opportunities in Machine Design

The demand for mechanization of production operations was creating manifold opportunities for mechanical engineers who specialize in machine design, B. P. Graves, consultant in design, Brown & Sharpe Manufacturing Company, Providence, R. I., told the Junior Conference.

Many young engineers were overlooking the opportunities because of an unfounded distaste or fear of the drafting board. Actually, Mr. Graves said, the drafting board was a natural spot for the young engineer to work up his ideas and to demonstrate his creative talents. The designer's task was to follow up and develop ideas originating from upper management, sales department's ideas picked up among the trade, and the designer's own ideas which come to him by keeping up with new developments in materials and methods.

The competition in the design field was stiff, he said, but there is no reason why a graduate should not exceed the men who have natural ability as designers but are without a full engineering education.

Advancement in the field was made through the steps of junior designer, assistant director of design, and then director of design, and depended entirely on ability to perform. Some chief draftsmen were advanced directly to industrial superintendent. Other promotions have been from chief draftsman to machine designer and to director of mechanical planning, while one assistant director of design was made a director of research.

New techniques in better manufacturing methods and in utilizing new ways of transmitting and controlling energy are creating many opportunities for the machine designer.

The automobile industry was asking for new fully automatic in-line machines. The same opportunities were open in the airplane-engine field where new ways of profile-turning, milling, and grinding are being sought.

Mr. Graves concluded his talk by listing a number of eminent men who began careers on the drafting board, advanced to machine-design positions, and on to leadership in industry. Among those he named were Ralph E. Flanders, U. S. Senator from Vermont; E. W. Miller, president, Fellows Gear Shaper; and J. B. Armitage, vice-president of engineering, Kearney & Trecker.

Self-Analysis

Mr. Anderson of the Savannah Section was the first speaker on the panel selected to discuss "A Current Plan for Young Engineers." Self-analysis is one of the most important steps in career development. It helps to define objectives and to check on progress, he said. Each man must study honestly his interests, ability, capacity, and the effect of his personality on those with whom he works. Young engineers no longer must face the task unaided because guides are available to help him approach self-analysis with an objective attitude. One of the best of these, he said, was the Self-Appraisal Form developed and distributed by the Engineers' Council for Professional Development.

Objectives

Early in his engineering career a young engineer should decide what his objectives are to be, Mr. Duggan of the East Tennessee Section said. But whether this objective is a prestige job, or one that will give him most satisfaction, or a job that offers a high salary, he should have a program in mind. It should be flexible enough for him to take advantage of opportunities as they develop. Mr. Duggan suggested that young engineers prepare for the responsibilities of their immediate superiors and warned against specializing too early.

Fundamentals

Mr. Vann of the Greenville Section discussed the importance of engineering fundamentals and how they can be used effectively. He advised Junior engineers to keep the fundamental facts of their jobs in a notebook for ready reference. As their experience grows,

REGION IV JUNIOR DELEGATES TO THE 1951 SPRING MEETING

(Left to right: Crawford S. Anderson, Jr., Savannah; Evert A. Young, Florida; Robert P. Sullivan, Chattanooga; Herbert G. Duggan, East Tennessee; E. J. Vann, Greenville; Leslie C. Wilbur, Eastern North Carolina; Leo A. Padis, Virginia; Albert F. Bullock, Birmingham; C. A. Dewey, Jr., Piedmont-North Carolina; and A. O. White, Jr., Atlanta.)

this knowledge will suggest short cuts for rapid evaluation and judgment of an engineering situation. These guides to judgment are the engineering tools of his job and many of them, he said, could be learned from older engineers. Technical knowledge, he concluded, was not enough. They should not neglect sports and hobbies.

Practical Experience

Mr. White of the Atlanta Section touched on the advantage of working early with a good engineer. Technical education was a means of gaining practical experience. He said his personal definition of the function of engineering is "to get the most out of the dollar." But before an engineer can contribute to engineering economy, he must have the experience and accumulate know-how. By observation and practice he must know how a job is being done before he can know how it can be done better. Since registration was legal recognition of experience, Mr. White advised all young engineers to become registered in their home states.

Articulateness

Before an engineer can become effective, he must learn how to communicate his ideas to those who work for him and to his superiors. The best way to do this, according to Mr. Wilbur of the Eastern North Carolina Section, was to relate new ideas to familiar ones and to present them in concrete rather than abstract terms. When interest in a new idea has been aroused, communication can be completed presenting the new idea in terms which can be easily grasped.

Loyalty

Business loyalty is an ingredient in the success of most engineers, according to Mr. Sullivan of the Chattanooga Section. He defined loyalty as dependability, interest, and constructive attitude to the job. It is expressed in many ways. The man who passes on willingly to younger men the knowledge he has accumulated is being loyal. On the other hand, the man who takes less pains with his job because he expects a checker to catch his mistakes is deficient in loyalty, Mr. Sullivan pointed out.

Friendships

The cultivation of friendships, so basic to all activities of life, was no less important in engineering. To work with others in a cordial atmosphere, to give of oneself, to receive the help of others—these were the rewards of friendships, Mr. Young of the Florida Section told the conference. But there were dangers to guard against. The cultivation of friendships must be a sincere personal experience. We must work at friendships by serving those with whom we work. We must give of our time and advice without expecting anything in return.

Working With Others

Many engineers fail not from lack of technical knowledge but from an inability to work with others. Mr. Padis of the Virginia Section offered a few rules as aids to getting along with superiors. He advised young graduates to show interest in their job by asking questions, but to be cautious about expressing opinions unless they were sure of the facts. They should do cheerfully and to the best of their ability any task assigned, no matter how menial it appeared. Usually there was a good reason behind every assignment. They should inform the boss about all the facts in his field of responsibility and they should give precedence to his ideas, but without losing their own initiative. Finally, they should accept the ideas of their associates.

Speaking on the same theme, Mr. Dewey of the Piedmont-North Carolina Section gave some advice on working with practical men in the plants. Most of these men did not have a formal engineering education, but they were storehouses of practical information of great value. By winning the confidence of these men, a young engineer can pick up in a relatively short time the fruit of many years of plant experience. He can cultivate their friendship by sharing with them the latest technical knowledge he possesses. Once a man demonstrates that he can get along with shopmen, he will have no difficulty winning the confidence of top management, Mr. Dewey concluded.

Civic Responsibility

Mr. Bullock of the Birmingham Section was the last speaker on the Junior Panel. Young engineers should begin early to recognize opportunity for technically trained men on the community level, he said. Public administration was the nation's biggest business and as such, needed engineers in office or on voluntary boards and agencies, if it were to be conducted on an efficient and economical basis.

ASME PHILADELPHIA SECTION HOLDS FAMILY NIGHT

(*Left to right* Mrs. Frank W. Miller, national president, ASME Woman's Auxiliary; W. J. Kinderman, chairman, Philadelphia Section; Dr. Lillian M. Gilbreth, Fellow and Honorary Member ASME; H. D. Moll, chairman, Junior Group, and Mrs. W. E. Karg, chairman, Philadelphia Section, Woman's Auxiliary.

On Jan. 23, 1951, the Junior and Senior Groups of the Philadelphia Section met with the Philadelphia Chapter of the ASME Woman's Auxiliary to hear Dr. Gilbreth speak on "Human Engineering." The idea of such a joint meeting was new and was proposed to meet the common complaint of wives of ASME members that they were never asked to attend ASME meetings. An audience of more than 550 heard Dr. Gilbreth propose a program for more intelligent use of human beings in American industry.)

ASME Standards Workshop

Nuclear Energy

THE Nuclear Energy Glossary Working Committee has announced the completion of Section VII of the proposed American Standard Comprehensive Glossary of Nuclear Terms used in Engineering. Section VII is devoted to instrumentation terminology.

The Working Committee is a subcommittee of the ASME Nuclear Energy Application Committee. Since 1945 it has been working on a glossary of nuclear terms, which is divided into nine sections. Section VII on Instrumentation will be the fourth to appear in print. Other sections now available are: III, Reactor Engineering; V, Chemical Engineering; and VI, Biophysics and Radiobiology.

Sections in preparation are: I, General Terms; II, Reactor Theory; IV, Chemistry; VIII, Isotopes Separation; and IX, Metallurgy.

Sections of the proposed glossary are being printed as individual booklets in order to make information available promptly so that through wide circulation and actual use, criticism can be considered by the Committee when revisions are undertaken. Eventually all sections will be placed under one cover.

Section VII was prepared by Dr. G. Wesley Dunlap, chairman of the Subcommittee on Instrumentation. Dr. Dunlap is with the General Engineering and Consulting Laboratory, General Electric Company, Schenectady, N. Y. Dr. John R. Dunning, dean of engineering, Columbia University, New York, N. Y., is chairman of the Nuclear Energy Glossary Working Committee.

The Committee invites users to send in sug-

gestions and criticisms of Section VII to the chairman of the NRC Glossary Conference, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

Piping Practices

BRITISH and American engineers concerned with standardization of piping practices in the petroleum industry met April 10–13, 1951, in the Engineering Societies Building, New York, N. Y.

The British delegation was aided by three liaison members of the ASA Sectional Committees on Pipe Flanges and Flanged Fittings (B16), Code for Pressure Piping (B31), and Wrought Iron and Wrought Steel Pipe and Tubing (B36).

They are: A. C. McGechan, Anglo-American Oil Company, London; H. J. Zass, Anglo-Iranian Oil Company, London; C. Schimmel, N. V. de Bataafsche Petroleum Mij., The Hague, The Netherlands.

The meeting was arranged at the suggestion of the British Standards Institution in order to discuss with the American Sectional Committees B16, B31, and B36, of which the ASME is administrative sponsor, such subjects as: Joint efficiencies, allowable stresses, temperature and stress limitations on butt and lapwelded pipe, mill test pressures in relation to allowable stress and joint efficiency, wall-thickness formulas, minimum wall thickness of pipe fittings, fabricated pipe work, and pressure-temperature ratings for equipment made of austenitic materials.

Pipe-Line Identifications

SECTIONAL Committee on Scheme for Identification of Piping Systems (A13) met in the Engineering Societies Building, New York, N. Y., April 4, 1951, to consider suggestions for revision of American Standard Scheme for the Identification of Piping Systems, last revised in 1928.

The Committee took under consideration two kinds of suggestions: (1) Revisions made necessary by the development of many new materials now commercially important and (2) revisions stemming from the recommendations of a general conference under the auspices of the American Standards Association, which met in October, 1950, to study the relation of several American standards to the proposed Military Standard Color Code for Compressed Gas Cylinders and Pipe Lines (MIL-STD-101).

This conference recognized that the military standard included fields covered by American Standards A13 and Z48.1 (American Standard Method of Marking Compressed Gas Cylinders to Identify Content—1942). Following a study by a subcommittee of the conference, Sectional Committee A13 was invited to study that section of Military Standard 101 which dealt with marking of pipe lines. It was recommended that Sectional Committee A13 consider the recommendation that primary identification of the content of the pipe lines be by the name of material and that use of color or other methods be utilized for secondary purposes of identification.

F. T. Clark, chairman of Sectional Committee A13, reported that a new sectional committee was being organized to work out that section of Military Standard 101 which deals with compressed gas cylinders.

Fine-Pitch Gears

AMERICAN Standard Inspection of Fine-Pitch Gears (ASA B6), the fourth in this series of standards on fine-pitch gears, prepared by the Sectional Committee on Standardization of Gears, was recently approved by the American Standards Association.

Other standards, all issued in 1950, were: Fine-Pitch Worm Gearing (B6.9), Fine-Pitch Straight Beveled Gears (B6.8), 20-Degree Involute Fine-Pitch System, (B6.7).

Completion of the series has been awaited by instrument manufacturers and manufacturers in the national defense industries. Alexander W. Luce, head, department of mechanical engineering, Pratt Institute, Brooklyn, N. Y., is chairman of the Sectional Committee. L. D. Martin, gear engineer, Eastman Kodak Company, Rochester, N. Y., was chairman of the Subcommittee on Fine Pitch Gears, directly responsible for preparing the standard.

Pressure Piping Corrections

SINCE the publication of the Code for Pressure Piping (ASA B31.1-1951) the following errors have been brought to the attention of The American Society of Mechanical Engineers:

Page 21, first note under Table 3*a* referring to *S* values: delete the word "tubing" in the first line.

Page 32, Table 6, note 6: indent the last two listings; "Double" and "ordinary" to line up with ASME in the listing above.

Page 34, Table on Pressure and Temperature Limitations, starred note: change (*e*) to (*f*).

Page 43, col. 1 (*d*): in the listing of materials indent the entry "ordinary" to line up with "Double-sub" in the preceding entry. In the same listing, delete the entry "Forge-welded . . . 0.80."

Page 64, par. 423, fifth line: change (*d*) to (*e*).

Page 65, col. 2, second line: change reference footnotes 2 and 3 to 1 and 2. Fourth line: add the word "allowance" after the term "water hammer."

Page 68, par. 426 (*b*) last line: change reference Par. 105 to 405.

Page 70, col. 1, second paragraph marked (*e*), fifth line: change reference footnote 2 to 1.

Page 82, par. 616 (*b*) (1) next to last line change reference ASA B16.18 to ASTM A307-Grade B.

Page 83, col. 1: change reference ASA B16.18 in lines 4, 15, 27, and 31 to ASTM A307-Grade B.

Page 84, col. 2, Par. (*g*): change formula to read

$$S_c = {}^3/_4(S + S_1)$$

In the note under Par. (*g*), second line: change reference Table 22 to 26 to 21 to 26.

In the same note, third line—add at end of line "and 34*a*."

Page 90, col. 1, example 2 (Formula 3) change minus sign to a plus in the denominator making it read

$$t_m = \frac{P\,D}{2S + 0.8P} + C$$

Col. 2, area 3, change second minus sign to equals, making it read

$$\text{Area } 3 = d(t_h - t_m)$$
$$= 15.25\,(0.328 - 0.324) = 0.061 \text{ sq in.}$$

Page 91, Fig. 7: change notation in illustration from "5 to 10 deg" to read "10 deg."

Anyone wishing to obtain a copy of these corrections may do so by addressing a request to the Standards Department, ASME, 29 West 39th Street, New York 18, N. Y.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York 8 West 40th St.	Chicago 84 East Randolph Street
Detroit 100 Farnsworth Ave.	San Francisco 57 Post Street

Men Available[1]

Professor, 66, married, graduate 1911, 30 years head of mechanical-engineering department, University of Philippines. Ten years with six American universities. Varied practical experience during vacation. Shop, design, and allied courses. Desires mild climate. Me-817-511-D-3.

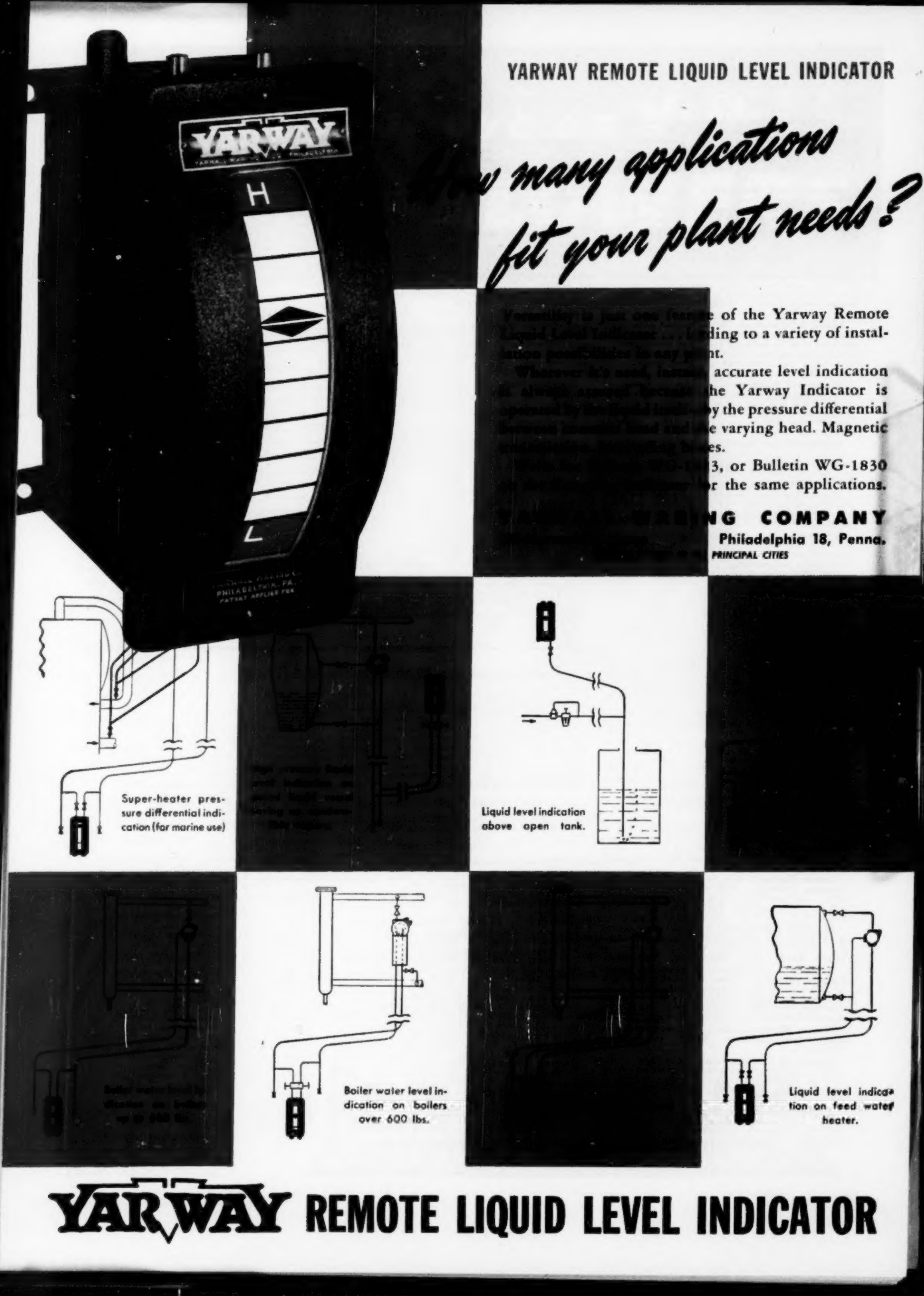
Mechanical Engineer, BS, 31, married. Three years' diversified experience, three years as power-plant engineer in 100,000 hp. Navy plant. Four years as professor of ME teaching heat, power, and fluid-flow courses. Consulting work. Desires position in heat and power field. Me-818.

Engineer, young, desires position abroad with American company in sales or administration. Design experience in most types of rotary machinery. BS and MS in ME. Europe preferred. Me-819.

Safety Director and Insurance Administrator for nationally known concern desires to relocate out of the metropolitan area. Married, veteran,

(*ASME News continued on page 462*)

[1] All men listed hold some form of ASME membership.



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many applications
fit your plant needs?
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3, or Bulletin WG-1830
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PRINCIPAL CITIES
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PHILADELPHIA, PA.
Super-heater pressure differential indication (for marine use)
Liquid level indication above open tank.
Boiler water level indication on boilers over 600 lbs.
Liquid level indication on feed water heater.
YARWAY REMOTE LIQUID LEVEL INDICATOR

BSEE, MS Economic Engineering, broad experience. Me-820.

Operating Assistant or Supervisory Engineer, fifty years old. Thirty years' practical experience in modern power-plant operation. Industrial and utility, some construction. Supervisory maintenance, safety, and management training. A-1 physical rating. Registered chief engineer. Me-821.

Assistant Plant Manager of 400 employees. Directly responsible for all production engineering, labor relations, and plant modernization. MBA Harvard Business School. BS in mechanical engineering, 32, single; will locate anywhere. Me-822.

Positions Available

Mechanical-Design Engineer, to take charge of drafting and design group, on design for production and manufacturing of electronic and electromechanical equipment. $7500-$8000. Northern N. J. Y-5148(b).

Research Director, 40-50, mechanical graduate, engineering and executive experience in small machine field, to take full charge of new product engineering and development for manufacturer of accounting and statistical machines and equipment. $12,000. Midwest. Y-5155.

Mechanical Engineer with experience covering instrument design, production, and assembly operations in precision fields, to be responsible for production redesign, assembly methods, and liaison with design-engineering staff. $5200-$6500. Queens, N. Y. Y-5169.

Mechanical-Job Engineer, over 30, with design, layout, specification, and installation experience covering heavy chemical equipment, to do office engineering and liaison work. $6600-$7200. New York, N. Y. Y-5170. Mr. Parker.

Project Engineer, considerable experience in the selection, application, and operation of stationary-installed large Diesel generator sets. $6500-$7000. New York, N. Y. Y-5177.

Engineers. (a) Methods engineers, 30-50, mechanical graduates preferred, minimum of five years' experience in methods work or machine of small parts and assembly. $6500. (b) Tool designers, preferably with five years' experience in the design of tools, jigs, and fixtures, for manufacturer of small parts. $5500. Mass. Y-5192.

Chief Engineer, 40-50, at least ten years' printing-press paper-machinery experience, to take charge of design, development, production, and application engineering for machinery manufacturer. $7000-$9000. New York metropolitan area. Y-5207.

Design and Development Engineer, mechanical graduate, at least four years' experience in the design of complicated mechanical assemblies and machinery. $6000-$8000. Suburban, N. J. Y-5208(b).

Industrial Engineers. (a) One with one to two years' experience in manufacturing engineering, to work as resident industrial engineer in plant. Will report to plant manager. This is somewhat of a training program, as applicant will be relocated about every six months until company's plants have been covered. Start $4139. (b) One for staff position in New York office of company. Should have at least four years' experience in industrial engineering; should know cost structures, have some accounting experience, etc. $5300-$5900. Y-5225.

Mechanical Engineer, experience in field of physics and laboratory work in fine measurements, to assist research director of steel products manufacturer. $6000. Philadelphia, Pa. area. Y-5250.

Patent Engineer with four or five years' experience, preferably with electromechanical devices. Any experience in U. S. Patent Office desirable. $6000-$7000. For 44-hour week. New York, N. Y. Y-5265.

Industrial Engineers for industrial-plant survey work, preferably with experience in metal stamping, chemicals, plastics, textiles, leather, or paper. $5400. New York, N. Y. Y-5266.

Engineers. (a) Designer, experienced in plumbing and sprinkler systems for public buildings. (b) Air-conditioning engineer to design and lay out air-conditioning systems for public buildings. One-year contracts. $7200 a year plus $240 a month living expenses. South America. Y-5267.

Master Mechanic, heavy construction equipment repair experience. $9600. Puerto Rico. Y-5273.

Director of Training, minimum of three to five years' experience in the administration and direction of training activities for large industrial-manufacturing organization. $6000-$6500. Upstate N. Y. Y-5277.

Project Engineer, mechanical or electrical, ten to 12 years' designing special production machinery, conveying systems, and metalworking equipment. Knowledge of machine-shop operations. Informed about hydraulics helpful. Will design and develop special production-equipment projects. $6600-$8400. Northern Chicago suburb. R-7502.

Engineers. (a) Plant engineer, graduate, 33-45, several years' experience in plant maintenance in a chemical-processing industry. Knowledge of design, maintenance, and motive power. Will supervise above activities processing equipment with mechanical draftsmen, for a manufacturer of chemicals, soaps, and fatty acids. Salary open. (b) Project engineers, mechanical, electrical, or chemical graduates, 25-30, with two or more years' experience in processing industries. Strictly office and project engineering on design of equipment for a manufacturer of soaps, fatty acids, etc. About $4200. Ill. R-7535.

Industrial Engineer at least five years' experience in methods, time study, standards, incentives, for general industrial engineering for manufacturer of shower cabinets. Company will pay fee. $6000-$7200. Ill. R-7539.

Plant Engineer, mechanical, capable of handling at senior piping engineer level, heating, air-conditioning, and refrigeration problems. Knowledge of sheet metal helpful. Work under director of engineering and follow through engineering shop and field work for a manufacturer. Salary open. Ill. R-7552(a).

Chemical Engineer, mechanical or chemical graduate, up to 50, good experience on heavy-equipment design and production, dredging or construction equipment helpful. Complete administration of the engineering department of 30 to 40 designers and draftsmen. Supervise engineering activities in structural and mechanical estimating general design and production for a manufacturer of dredging equipment. $10,000-$15,000. East. R-7593.

Engineers. (a) Chief mechanical engineer or mechanical project engineer, seven to ten years' experience in radio and television, translating customers' conception into mechanical prints, specifications, and bills of material for manufacturing and assembly purposes; informed about operations required on sheet metal, plastics, and metal parts. Knowledge of machining operations, stresses, strains, strength of materials, and other mechanical requirements. Competent to accept original conceptions and follow through to completion with minimum of supervision. Capable of supervising work of others for radio and television manufacturer. $10,000 or more. (b) Project engineer, electronics, sufficient experience to carry out development and manufacturing projects with minimum of supervision on radio and television sets under the direction of a director of engineering; informed about domestic and commercial practices for a radio and television manufacturer. $7500-$10,000. Ill. R-7636.

Plant Engineer, mechanical or chemical, five years' experience in chemical process, process construction, maintenance, and material handling; some previous supervisory responsibility desired. Will be concerned with a large expansion program and be required to deal with maintenance, construction, and operational personnel for a manufacturer. About $5400. Ill. T-7550.

Director, experimental and development mechanical engineer, 35-40. Aggressive with administrative ability. Experienced in refrigeration, emphasis on engineering, sheet-metal fabrication, tooling, processing, welding, and finishes. Salary open. Minn. T-7615.

Plastics Research Fellowship

A FELLOWSHIP in plastics research has been established by the Bakelite Division of the Union Carbide and Carbon Corporation, at Princeton University, Princeton, N. J., it was announced recently. The recipient will do graduate work at the University's Plastic Laboratory, which contains facilities for a broad program of plastics research.

The laboratory's research program has resulted in the development of five new laminated materials, four new molding compounds, a polyurethanes potting compound for electrical components, as well as a number of new methods of evaluation and theories of polymerization. This work has been performed for the Army, Navy, and Air Force through contracts with the U. S. Army Signal Corps.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after May 25, 1951, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ADAMS, ROBERT C., Kansas City, Mo.
BAKER, ROBERT A., Newark, N. J.
BARDWELL, RICHARD A., Danville, Ill.
BARTHOLOMAEI, NATHANIEL T., Hannawa Falls, N. Y.
BEATENBOUGH, PAUL K., JR., Kansas City, Mo.
BENNETT, GEORGE E., Danville, Ill.
BENTON, DOUGLASS H., Chicago, Ill.
BERTRAND, J. V., Forest Hills, N. Y.
BOWERSOX, HAROLD W., Dearborn, Mich.
BRENNAN, DAVID A., Detroit, Mich.
BUNTS, Louis E., Akron, Ohio
BURPEE, ROYAL H., JR., Astoria, N. Y.
CALDERARA, LODOVICO B., New York, N. Y.
CHAMBERLAIN, JAMES W. V., Akron, Ohio
CHASE, HAROLD J., Schenectady, N. Y.
CONNELLY, JOHN N., Corning, N. Y.
CONSIDINE, JAMES T., Chicago, Ill.
COOPER, G. P., Toronto, Ont., Can.
CRUMP, JACK S., Corpus Christi, Texas
DEXTER, ADWIN G., Kingsport, Tenn.
DI TARANTO, ROCCO A., Philadelphia, Pa.
DOUD, WILBUR O., Muncie, Ind.
EBY, IVAN D., New York, N. Y.
ECKLES, CHARLES E., Lockport, N. Y.
EL-WAKIL, M., Alexandria, Egypt
ERLICK, HOWARD B., Philadelphia, Pa.
FISCHER, ELMER M., Los Alamos, N. Mex.
FISH, THERON J., Swampscott, Mass.
FLODIN, K. N., Latrobe, Pa.
GARBER, PAUL B., JR., Chattanooga, Tenn.
GRISSLER, HENRY, Sharon, Mass.
GERSTENFELD, ARTHUR, Brooklyn, N. Y.
GILBERT, HAROLD J., La Marque, Texas
GOURLIE, W. H., West Hartford, Conn.
GROTH, WILLIS G., El Paso, Texas
HAMULAK, MICHAEL A., Carteret, N. J.
HARRIS, FRANK A., Chattanooga, Tenn.
HATHAWAY, C. W., Belle, W. Va.
HEDGES, JOSEPH W., Pasco, Wash.
HORMUTH, MARVIN M., San Antonio, Texas
HUBECK, CHARLES, New York, N. Y.
KARRH, WILEY J., Norris, Tenn.
KATRIS, CONSTANTIN D., Athens, Greece
KERN, GEORGE E., Ridgewood, N. Y.
KNEPSHIELD, ROBERT E., Erie, Pa.
KOCH, MILTON E., Milwaukee, Wis.
KORNREICH, DONALD W., Southbury, Conn.
LERNER, BERNARD J., Austin, Texas
LUERS, HARRY L., Baltimore, Md.
MARCHETTO, CAESAR P., Union City, N. J.
MARCINIZYN, STEPHEN W., Pittsburgh, Pa.
MARTYN, WILLIS S., New York, N. Y. (Rt&T)
McCORMACK, GERALD M., Los Altos, Calif.
McCREERY, C. WAYNE, Toledo, Ohio
McKITRICK, W. D., Toledo, Ohio
McNAB, JAMES R., Rock Hill, S. C.
McTERNAN, EDWARD K., Queens Village, N. Y.
MEHTA, INDER MOHAN, Agra, India
MEIER, DONALD R., Erie, Pa.
MOHLER, HAROLD S., Hershey, Pa.
MOORES, WM. D., Tulsa, Okla. (Rt)
MOSELEY, I. N., Vinton, Va.
NEUSIHIN, IRVING, Washington, D. C.
PARSONS, CHARLES H., San Carlos, Calif. (Rt&T)
PAVILUK, JOHN, New York, N. Y.
PECKMANN, LYLE F., Bloomington, Ill.
PFAU, JULIUS H., Worcester, Mass.
PISTOLE, GORDON S., San Francisco, Calif.
PREM, LAWRENCE L., Flushing, N. Y.
REISMAN, COLEMAN, Los Angeles, Calif.
ROBEN, EDWARD, Guttenberg, N. J.
ROWDY, WILLIAM H., Fyzabad, Trinidad, B. W. I.
SAHNEY, MAHENDRA, Clintonville, Wis.

(*ASME News continued on page 464*)

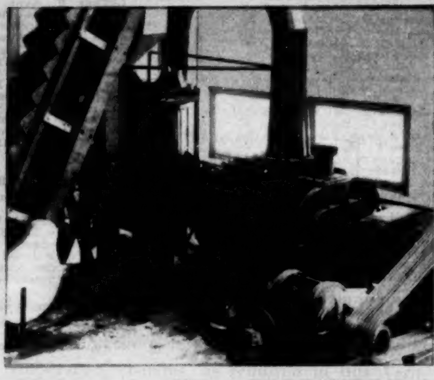
Keep your eye on V·P·L WHEN SELECTING BLOWERS

CENTRIFUGAL

Motor-driven Type OIB Centrifugal Blower in chemical processing plant. Capacity 19,000 cfm.

Wet bark is blown 400 feet, from charger to stoker, by R-C Rotary Positive Blower in this Nova Scotia paper mill.

ROTARY



You can't afford to risk shutdowns today because of unsatisfactory or inadequate equipment performance. To keep production moving at the required fast pace, calls for blowers or gas pumps that continuously deliver positive Volume at required Pressure—and at Low power costs to reduce operating expense.

You get these 3 essentials from R-C Blowers and Gas Pumps. Whether your needs call for Centrifugal or Rotary Positive units, we can match them from our exclusive *dual-ability line*. With capacities from 5 cfm to 100,000 cfm, you can usually find R-C units that closely fit your demands, with resultant savings in time, cost, space, weight and power.

From an experience of almost a century of blower building, our engineers will gladly make suggestions of the right R-C equipment to move or measure gas and air to keep production going.

Roots-Connersville Blower Corporation, 510 Michigan Ave., Connersville, Indiana.

ROOTS-CONNERSVILLE

BLOWER BUILDERS R-C SINCE 1854

ONE OF THE DRESSER INDUSTRIES

ST. CLAIR, DONALD R., Chicago, Ill.
ST. JOHN, JOHN M., Dedham, Mass.
SALDAT, P., Niagara Falls, Ont., Can.
SEIBERT, ALLAN G., Kenmore, N. Y.
SFORSINI, LEWIS J., Rochester, N. Y.
SHARMA, RAM KRISHAN, Rohtak, Punjab, India
SHEQUINE, E. R., Teaneck, N. J. (Rt)
SHORT, MICHAEL O., London, England
SILVA, ROBERT, South Easton, Mass.
SILVER, HAROLD, Camp Rucker, Ala.
SILVERMAN, MELVIN, Berkeley, Calif
SMITH, LOUIS C., JR., Hershey, Pa.
SOUTH, W. D., JR., Atlanta, Ga.
SPEER, WILLIAM S., Erie, Pa.
STANISH, RAY J., Cleveland, Ohio
STEVENSON, HENRY S., New Brunswick, N. J.
STOEHR, FRED, Sheboygan, Wis.
STONE, WALTER N., East Granby, Conn.
STRASSBERGER, JOHN W., New York, N. Y.
TALLEY, ROBERT E., Western Springs, Ill.
THOMAS, TOM D. B., Bloomfield, Ind.
TROST, ADOLPH, Omaha, Neb.
ULRICH, JAMES, New York, N. Y.
VASILIU, J., New York, N. Y.
VERNER, GEORGE, Town of Mt. Royal, P. Q., Can.
WEIL, HAROLD M., Ridgewood, N. J.
WERTS, WAYNE E., Russell, Iowa
WILLIAMSON, JACK D., Adair Village, Ore.
WINTER, CHARLES, Wappingers Falls, N. Y.
ZEIGLER, SAMUEL J., Washington, D. C.

CHANGE IN GRADING

Transfers to Member and Associate

ALLEN, HERBERT, Houston, Texas
ANDERSON, JOHN A., New York, N. Y.
BAER, HERMAN W., New York, N. Y.
BURSTADT, ERWIN W., Detroit, Mich.
CALL, WILLIAM R., Milwaukee, Wis.
CAMPBELL, FRANK R., Golden, Colo.
CARSON, JOHN M., New York, N. Y.
COMBS, WELDON K., Dallas, Texas
DEAN, LYLE A., Walnut Creek, Calif.
DRINKA, J. J., West Allis, Wis.
EGER, GEORGE W., JR., Peoria, Ill.
ERGLER, PAUL C., Baltimore, Md.
ERLACHER, A. JOHN, Philadelphia, Pa.
FREDD, JOHN V., Dallas, Texas
HARDWICK, JAMES B., Lawrenceburg, Ind.
HELBIG, ROBERT W., River Forest, Ill.
HELLER, ELMER W., Haifa, Israel
HICKS, EARL J., Bartlesville, Okla.
HILBORN, W. DWIGHT, Pasadena, Texas
INGLEE, CLINTON F., Amityville, N. Y.
KUEHN, KURT F., Arlington, Va.
KULIEKE, FREDERICK C., Alliance, Ohio
LAMBERTUS, HAROLD, Indianapolis, Ind.
LEE, GEORGE W., Staten Island, N. Y.
LIONE, LEONARD V., Albany, Ga.
MEDLAR, LEWIS A., Philadelphia, Pa.
MESSENGER, PAUL B., Marion, Ohio
NAPP, ANTHONY E., Flushing, N. Y.
NOONAN, EDWARD F., JR., Takoma Park, Md.
PETRENCO, ANATOLY V., Ann Arbor, Mich.
PHILLIPS, HERBERT S., Norton, Mass.
ROPER, EDWARD H., Riverside, Conn.
SALIBIAN, M., Forest Hills, N. Y.
SHREEVE, ROBERT E., Baltimore, Md.
TIVY, V. V. ST. L., Foxboro, Mass.
TRUSLER, WALTER R., Toronto, Ont., Can.
WALKER, JAMES J., Charleston, W. Va.
WEIL, JOHN M., Albuquerque, N. Mex.

Transfers from Student Member to Junior 338

Obituaries

William Lamont Abbott (1861–1951)

WILLIAM L. ABBOTT, retired chief operating engineer, Commonwealth Edison Co., Chicago, Ill., died Feb. 20, 1951. Born, Whiteside County, Ill., Feb. 14, 1861. Parents, Asa M., and Sarah (Sperry) Abbott. Education, ME, University of Illinois, 1884; LLD, 1929. Married Carrie Entwhistle, 1887; children, Arthur William, Helen (Mrs. O. C. F.) Randolph (dec.), Robert Edward, Josephine Ellenor, Dorothy Caroline (Mrs. Leonard) Knopf. He was an authority on coal combustion and storage and wrote numerous technical papers. Mem. ASME, 1891; Fellow ASME, 1936; Hon. Mem. ASME, 1940. Served the Society as Manager, 1907–1910; President, 1926.

Luther Symmes Ayer (1876–1951)

LUTHER S. AYER, retired manager, International Motor Co., Plainfield, N. J., died Jan. 26, 1951. Born, Winchester, Mass., Oct. 17, 1876. Parents, Eugene Albert and Addie (Whitney) Ayers. Education, high-school graduate; Massachusetts Nautical Training School. Married Helen Fosdick, 1901 (divorced). Married 2nd, Helen Davis, 1928. Mem. ASME, 1914. Survived by wife and five children by his first marriage, Mrs. Roswell Stafford, Plainfield, N. J.; Fosdick W., Haddonfield, N. J.; Miriam C., Wellesley, Mass.; Norman L., Duluth, Minn.; Albert S., Aruba, Netherlands West Indies; and three grandchildren.

John Martin Barney (1871–1951)

JOHN M. BARNEY, structural engineer, National Advisory Committee for Aeronautics, Langley Field, Va., died Jan. 15, 1951. Born, Budapest, Hungary, Nov. 25, 1871. Parents, John M. and Fredericka Barney. Education, home schools; Michigan Agricultural College. Naturalized U. S. citizen. Married Norma L. Mollenkamp. Mem. ASME, 1946. Survived by wife.

William Lewis Iliff (1890–1951)

WILLIAM L. ILIFF, Eastern sales manager, Hyatt Roller Bearing Co., Harrison, N. J., died Feb. 3, 1951, at Mountainside Hospital, Glen Ridge, N. J. Born, Newton, N. J., Dec. 1, 1890. Parents, John and Mary Iliff. Education, ME, Stevens Institute of Technology, 1913. Married Amanda Seibert, 1917. Jun. ASME, 1917; Mem. ASME, 1922. Served as ASME representative on ASA Ball and Roller Bearing Standardization Committee. Survived by wife, two sons, Robert E. and Hugh H.; his parents, Mr. and Mrs. J. Iliff; a brother, Fred C.; and two sisters, Mrs. Philip M. Hardin and Laura H.

J. Hall Taylor (1877–1951)

J. HALL TAYLOR, chairman of the board, Taylor Forge and Pipe Works, Chicago, Ill., died Feb. 13, 1951. Born, Paris, Ky., Aug. 3, 1877. Parents, Irwin and Elizabeth (Hall) Taylor. Education, Chicago English High School, Manual Training, 1895; Lewis Institute. Married Nina Atkinson, 1902. Mem. ASME, 1912. Served the Society as member of ASME Standardization Committee, 1941–1946; chairman, 1946–1947; advisory member, 1947 to his death. Survived by wife and two sons, E. Hall and James L.

Harry Lester Terwilliger (1873–1951)

HARRY L. TERWILLIGER, retired district manager, Ingersoll-Rand Co., San Francisco, Calif., died Feb. 10, 1951, in Palo Alto, Calif. Born, Whitney Point, N. Y., Nov. 11, 1873. Parents, William and Rebecca (Warwick) Terwilliger. Education, ME, Cornell University, 1897. Married Winona M. Pratt, 1903. Assoc. ASME, 1901. Survived by wife and two children, Mrs. George E. Webster, Inglewood, Calif., and Hal Rowe, Willow Grove, Pa.

Jay Manuel Whitham (1858–1951)

JAY M. WHITHAM, consulting engineer in steam and hydraulics, Philadelphia, Pa., died Feb. 24, 1951, in Chestnut Hill, Pa. Born, Warren, Ill., Aug. 24, 1858. Parents, John and Caroline A. (Rowe) Whitham. Education, engineering course, U. S. Naval Academy, 1881. Married Rebecca Emmet Dashiell, 1884 (died 1946). Mem. ASME, 1883. Author of "Steam Engine Design," "Constructive Steam Engineering," "Water Rights Determination," and several articles which were published in technical journals. Survived by four children, Dr. Jay D., New York, N. Y.; Dr. Lloyd B., Baltimore, Md.; Mrs. Eleanor H. (Thom) Williamson, Jr., Moundsville, W. Va., and Mrs. Margaret V. (A. Claude) Howard, Chestnut Hill, Pa., with whom he made his home

Fred Morrell Zeder (1886–1951)

FRED M. ZEDER, vice-chairman of the board of directors, Chrysler Corp., Detroit, Mich., died in Miami, Fla., Feb 24, 1951. Born, Bay City, Mich., March 18, 1886. Parents, Rudolph and Mathilda (McKendry) Zeder. Education, BSME, University of Michigan, 1909; Hon. ME, 1933; Hon. DE, 1944. Married Lucille Monroe, 1918. He either pioneered or aided in the development of the high-compression automobile engine, hydraulic, four-wheel brakes, the downdraft carburetor, the automatic clutch, and many other improvements. Mem. ASME, 1920; Fellow ASME, 1946. Survived by wife, a son, Fred M., Jr., New York, N. Y., and three daughters, Mrs. E. L. Fox, New York, N. Y.; Mrs. John Posselius, Detroit, Mich.; and Mrs. Gordon Blair, Glenview, Ill.

ASME Master-File Information

(Not for use of student members)

Please print — **Check mailing address**

Name ....
Last First Middle

Home address .... ☐
Street City Zone State

Name of employer ....

Address of employer .... ☐
Street City Zone State

Product or service of company ....

Title of position held ....

Nature of work done ....

I am a subscriber of (please check)

Transactions ☐ Journal of Applied Mechanics ☐ Applied Mechanics Reviews ☐

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Keep Your ASME Records Up to Date

HEADQUARTERS depends on its master membership file for answers to hundreds of inquiries daily pertaining to its members. All other Society records and files are kept up to date through changes processed through it. The listings in future ASME Membership Lists will be taken directly from the master file. It is important to you that it lists your latest mailing address and your current business connection.

Four weeks are required for complete processing of address changes.

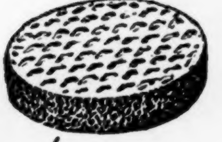
The mailing form on this page is published for your convenience. You are urged to use it in reporting recent changes.

Your mailing address is important to Headquarters. Please check whether you want your mail sent to home or office address.

Unfailing compressibility of

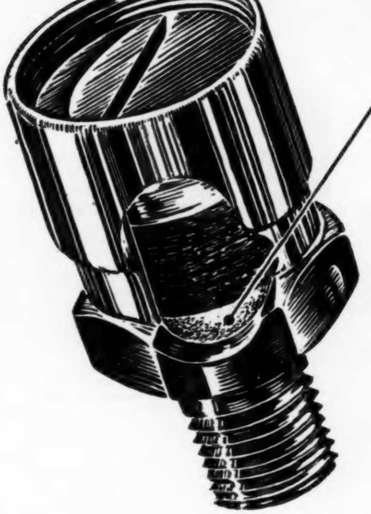
SPONGEX®

CELLULAR RUBBER



DAMS WATER ...VENTS AIR

in Ventmaster automatic valve for hot water heating systems



Ventmaster automatic air vent
by
The Keeney Manufacturing Co.,
Newington, Connecticut.

Uncompressed, this disc of Spongex cellular rubber forms an orifice of thousands of interconnecting cells which permit air to pass through the valve. Water, following the same path, causes companion hygroscopic discs to swell, compressing Spongex into a dam to shut off water flow. Heat from the radiator dries the hygroscopic discs; the Spongex cells open. Air again passes through the valve. This cycle continues year after year.

Unfailing compressibility under widely varying temperature changes, as required in this Ventmaster application, is an outstanding characteristic of Silicone Spongex. Even at −100° F or 450° F, Silicone Spongex continues to function.

Years of specialization have developed a Spongex know-how with cellular rubber . . . its advantages and limitations under widely varying applications. We always are glad to have you draw on this experience for your cellular rubber needs.

This new booklet on the properties of, test data on, and specifications for cellular rubber has just been released. It's concise, and a valuable reference source. Write for a free copy today.

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ANOTHER NOTABLE ACHIEVEMENT IN SERVICE LITERATURE BY JENKINS

THE NEW

BOOK No. 2

Nos. 26—50

practical piping layouts

The second series of twenty-five basic Piping Layouts (published by Jenkins Bros. in leading industrial, professional, and engineering publications) is now available in booklet form.

If you are among the hundreds of valve-users who received a copy of the first book, or if you saved any of the fifty Jenkins Piping Layouts as they appeared, then you know how helpful this information can be in planning any valve installations.

This new book brings you not only 25 practical piping layouts, arranged in convenient form for quick reference. It also includes a section on the fundamentals of valve design and application to help you select the type of valves best suited for the service.

Use it as a guide to proper valve selection and placement for longest service life and lowest operating costs. Use it also for an introduction to the wide range of Jenkins Valves for every industrial engineering and plumbing-heating service. You can obtain a copy by requesting it on your business letterhead. Address:

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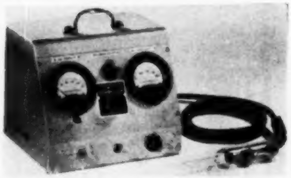
• *NEW EQUIPMENT*

Leak Detector

A new and extremely sensitive inexpensive leak detector for use in vacuum systems down to one micron Hg has been announced by Distillation Products Industries, Division of Eastman Kodak Co., Rochester, N. Y.

The new Leak Detector, Model LD-01, is expected to particularly appeal to those who have only occasional need for a leak detector and whose purpose is merely to establish the presence of a leak too small to be detected by more obvious signs.



In operation the glass sensitive tube of the leak detector is sealed into the system under test and the system is then pumped down to a moderate vacuum. A jet of harmless Freon gas, readily available in small cylinders, (or other halogen-containing gas) is then directed against portions of the system suspected of leaking. When the jet strikes a leak there is a sudden deflection of the meter needle on the instrument face, because the gas—entering the system—instantly increases the ability of a hot platinum anode in the sensitive tube to emit positive ions.

The Model LD-01 circuit employs only three standard radio tubes and is housed in a cabinet $10\frac{1}{4}$ in. wide, $7\frac{1}{2}$ in. high, and 8 in. deep. This cabinet comes on a dolly for convenience in working around large systems. The sensitive tube is 5 in. long, $1\frac{15}{16}$ in. in diam, and has a 3-in. tubulation, $\frac{7}{16}$ in. OD. This may be connected to a system under test with a fitting of the stuffing box type.

Helical Wire Thread Inserts

The maintenance department serving one of New York City's subway lines has the frequent problem of replacing worn and stripped threads in the axle-cap bolt holes of its subway car motor-frame castings. Repair of these holes is expedited by the use of stainless-steel helical-wire thread inserts, introduced by Heli-Coil Corp., Long Island City, N. Y.

These inserts permit the use of the same size cap screws in the repaired holes as were used in the original holes. This eliminates the matching operations that would be necessary if oversize threads and cap screws were used to solve the damaged thread problem. Use of these inserts also eliminates the need for drilling out larger clearance holes in mating parts. In addition, these preformed wire inserts provide threads that are stronger, more wear-resistant, and more corrosion-resistant than the original threads.

Thread repair is accomplished in the following manner: The damaged thread is cleaned out with a drill slightly larger in outside diameter than the major diameter of the original thread; the hole is retapped using an oversize, special-threaded tap; and the helical thread insert is installed.

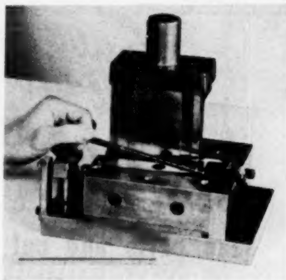
Threads in a motor frame were repaired in this manner. The casting had a badly worn thread, a completely stripped thread, and a broken $2\frac{1}{4}$-in. cap screw. Original holes had $1\frac{9}{32}$-7 tapped threads.

These three holes were repaired by: (1) Drilling out the holes and the stud with a $1\frac{21}{64}$-in. drill, (2) tapping with a special oversize Heli-Coil tap identified with a $1\frac{9}{32}$-7 marking, and (3) installing a stainless-steel Heli-Coil thread insert, to bring the hole back to size. This insert, having coils of diamond-shaped cross section, has threads on its outside diameter conforming to the special tap and internal threads conforming to the original thread.

The entire operation was completed in approximately 55 min. The formed wire inserts provide smooth threads that permit frequent assembly and disassembly operations with a minimum of thread wear. Also, corrosion caused by infiltration of water or other reactive liquids and gases will not cause deterioration of these threads.

The superior strength of the 18-8 stainless steel more than compensates for the loss of material in the bolt-hole boss. Also, increased loading strength is achieved because the helical insert automatically adjusts itself to mating threads on both the casting and the stud, thereby distributing the load properly over each thread.

New Thread Rolling Fixture



A simple rolling fixture, faced with blanks of Carboloy cemented carbide, and used in a No. 21 Bliss press, is doing the job of a thread generating machine in the Appliance & Merchandise Department, General Electric Co.

The operation consists of rolling two spiral grooves 0.020 in. deep in 0.260 in. diam fan rotor shafts. The fixture rolls the shaft downward past two blades of Carboloy cemented carbide set at the proper helix angle. It is estimated the Carboloy blades need repolishing only after around 200,000 pieces. High speed blades have also been tried in this operation and a total of 60,000 pieces obtained over the tool life (representing 10 regrinds).

Railway Motor

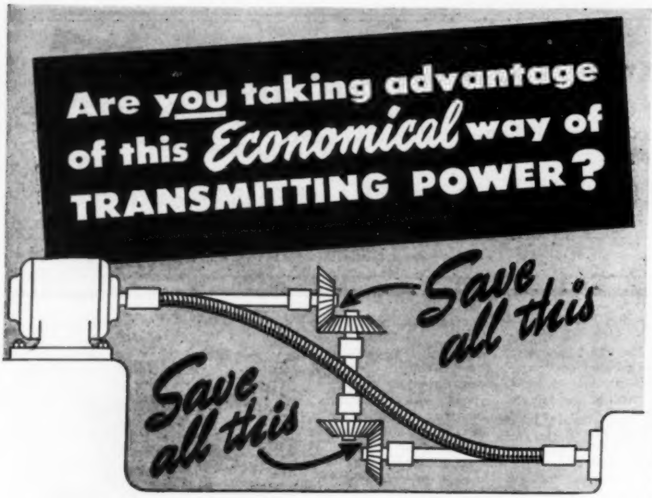
A smaller, lighter railway motor capable of producing 90-mph sustained speed, and a new system of control to insure smoother acceleration and performance have been developed by engineers of the Westinghouse Electric Corp., Pittsburgh, Pa.

Company spokesmen disclosed that the Pennsylvania Railroad currently is equipping a number of its multiple-unit cars with the new motors and control. Multiple-unit cars are self-propelled railway cars used for commuter service between closely adjacent stops.

The new motor weighs 5405 lb, as compared to 6625 lb for its predecessor, much of this weight saving being in the armature. This smaller armature, operated at a higher speed, enables the motor to develop about the same starting and accelerating tractive efforts at approximately the same rating. The new motor is rated 225 hp; the previous design was rated 200 to 210 hp.

With fewer working parts and simpler control, greater reliability in service and lower maintenance expense should be realized. Ventilation air is blown in through the rear of the motor and comes out through the commutator-end housing. Carbon dust is thus blown out of the motor instead of into the windings.

Continued on Page 42



S.S.WHITE *FLEXIBLE SHAFTS*

save parts and cut assembly time and cost

THE illustration above speaks for itself when it comes to demonstrating the advantages of an S.S.White flexible shaft power drive. With one of these shafts, power can be taken from one point and delivered to any other point as simply and as economically as it could possibly be done.

The resulting advantages are most important in any design work—fewer parts, easier assembly, faster production, lower costs. They make it worth while considering S.S.White flexible shafts whenever you have a power transmission problem.

A large selection of sizes and characteristics suit S.S.White flexible shafts to a wide range of drive requirements. For details on these versatile, dependable mechanical elements,

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THE S.S.White DENTAL MFG. CO. INDUSTRIAL DIVISION

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To further facilitate maintenance, the brush holders are mounted on the end housing, and not in the frame. Design also permits armature and pinion housing to be removed intact, so that the commutator can be ground and replaced without pulling pinions or worrying about bearings.

Each MU car is equipped with two motors, each operating individually.

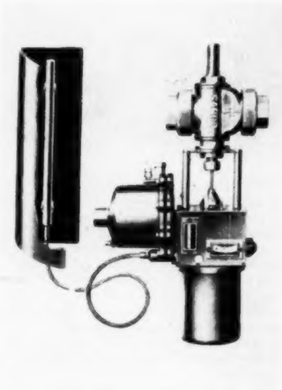
Modulating Control

The type W Sarcostat, a new modulating control for steam and hot-water systems actuated by weather and pressure, has been announced by Sarcotherm Controls, Inc., New York, N. Y. The new device controls the volume of steam to heating systems in relation to the outside temperature. The steam may be supplied directly to steam radiators and convectors heating water for forced hot-water heating systems.

The Sarcostat automatically feeds only enough steam to the building, heating zone, or converter to balance its heat loss under any given weather condition. Equal distribution is assured through the use of orifice plates in steam radiator valves.

A control panel is provided for night shutdown and quick morning pick-up at any predetermined time.

The heart of the Sarcostat system is the fully modulating master control which is fitted on the main steam line or in each zone.



In hot-water systems supplied through convertors, this control is installed in the steam supply to the convertor.

The throttling position of the valve is determined by the outdoor bulb and also by the steam pressure existing in the system (or in the convertor).

The liquid-filled outdoor bulb 1 acts to open the valve wider as the weather gets colder. However, mechanism 2 saves heat by preventing the valve from opening any wider than is required to provide sufficient pressure in the system for a given outdoor temperature.

Mechanism 2, actuated by the steam or vapor pressure in the system, positions the fully modulating valve at various intermediate points. It automatically maintains predetermined pressures for different outdoor temperatures.

To insure even heat distribution during the throttling action of the valve, correctly sized orifice plates are installed in steam radiator or convector valves. These orifice plates are included with each Sarcostat system.

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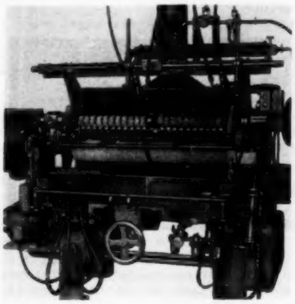
Surface Finishing Machine

A surface finishing machine capable of simultaneous coverage both inside and outside of spoon and fork bowls and similarly shaped small parts has been introduced by Clair Manufacturing Co., Olean, N. Y.

Although developed through co-operation with several large silverware manufacturers, the Clair No. 204 surface finishing machine is suitable for use in other fields where similar contour problems exist. In operation, the



rack of this machine moves in order to expose simultaneously the inside of the bowl-like shape to small-diameter preformed convex buffs and the outside diameter to large-diameter concave buffs. Adjustments which compensate for variations in bowl depth and length are included in the design.

Featuring a waist-high design for ease in loading, this two-spindle machine has an electrohydraulic actuation system, with totally enclosed hydraulic circuits which are invulnerable to abrasives. Rolls are opened and closed by a compressed-air circuit which also permits automatic float of the counter-balanced rolls in following irregular contours. A minimum working space 38 in. wide is provided by 40-in-long rolls in diameters up to 9 in. Adjustments for speed and magnitude may be made without stopping the machine, and over 20 optional features and modifications are available.

30-Ft Boring Mill

The most expensive single machine tool ever purchased by the Allis-Chalmers Manufacturing Co., Milwaukee, Wis., costing more than $600,000, has been placed in operation at the firm's West Allis Works. The tool is a 30-ft heavy boring and turning mill and is the second largest machine tool at the firm.

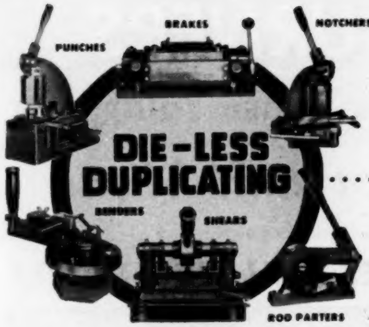
The new mill, built by the Lima-Hamilton Corp., can machine single pieces up to 30 ft, 5 in. in diam and 17 ft high. It is being used to increase Allis-Chalmers capacity for the manufacture of large generators, condensers, steam, and hydraulic turbines.

The new 30-ft mill weighs approximately 500 tons and has an over-all height of 48 ft—37 ft of which is above the floor line. The unit has a width of 59 ft and a depth of 29 ft.

The table which is supported by the center bed section is 25 ft in diam and 24 in. deep. The table, including the table gear, weighs approximately 78 tons.

The housings, each of which weighed 130,000 lb in the rough, are provided with side braces cast integral. The mill has an elevating-type crossrail on which are mounted two swiveling rail heads with 14-in. octagonal boring bars about 18 ft in length.

Continued on Page 44



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ENGINEERS—DESIGNERS—PRODUCTION MEN should all have this informative catalog which contains technical data covering Di-Acro Machines and our offer of "Die-Less Duplicating" Engineering Service to aid in solving design and production problems. WRITE FOR YOUR COPY TODAY.

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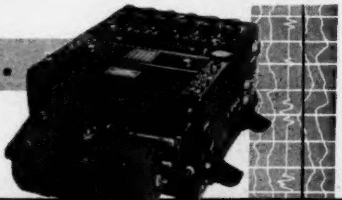

for complete oscillographic recording

The S-8 Oscillograph, long the standard of oscillographic recording, has been improved to meet the expanding demands of modern research. The NEW Type S-8 Oscillograph has *all* the inherent capabilities you need to record rapidly changing phenomena such as vibration and dynamic strain.

A few of the newest features are:

QUICK-CHANGE TRANSMISSION—16 record speeds over range of 120:1

FULL RESILIENT MOUNTING makes possible use of super-sensitive galvanometers

CHART TRAVEL INDICATOR provides continuous indication of chart motion

NEW GALVANOMETER STAGE takes all Hathaway galvanometers for recording milliamperes, microamperes, and watts.

NEW RECORD-LENGTH CONTROL and NUMBERING SYSTEM for long, trouble-free service

All the other valuable features characteristic of the S-8 are retained. Investigate the NEW Type S-8 and its 170 types of galvanometers.

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OIL BURNERS

GAS BURNERS & ALLIED EQUIPMENT

for Power and Heat

THESE PICTURES TELL THE STORY!

Before →

A view of boiler room of large Eastern industrial plant before underfeed stokers were replaced with National Airoil Oil Burners.

← *After*

After installation of NATIONAL AIROIL TYPE S A. Oil Burners under the four boilers pictured above. Note that lower front walls of the three right hand boilers have been extended. Also note angle fronts to permit firing at high ratings without impingement of flame on side walls. Either forced or natural draft may be used. Total capacity 2800 HP. Large savings were made on stoker and ash handling equipment repairs, brickwork maintenance. One operator now easily cares for all four boilers.

For 39 years—continuously since 1912—NATIONAL AIROIL BURNER COMPANY has devoted its entire efforts to the design, development, manufacture and application of successful Oil and Gas Burning Equipment. This same equipment is used throughout the U.S. and foreign countries. — Many models in varied sizes are available to cover a wide scope of applications and special problems. — Send us details of your plant; our engineering department will gladly offer recommendations.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes: STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

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SOUTHWESTERN DIVISION: 2512 SOUTH BOULEVARD
HOUSTON 6, TEXAS

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The table gear is driven by two pinions located 180 deg apart on the center line of the table which is parallel to the face of the crossrail.

Bars and saddles are provided with electronic feeds. A feed and traverse motor is mounted on a gear box attached to the rear of each end of the crossrail. The motor is a 15/20-hp d-c motor with speeds ranging from 30 to 1800 rpm. This range, together with one back gear, gives a total range of 1500 to 1, suitable for boring, turning, and milling operations.

A control station is located on each crossrail head and on consoles in front of each housing. All table movements and the elevating and clamping of the crossrail may be controlled from any one of these four stations.

The feed, traverse, inching, and selection of bars and saddles on both heads may be controlled from the two consoles and similar control for each individual head is provided on the control stations on the heads. The control of the automatic clamping of bars and saddles and the swiveling of the bars is located on the head-control stations.

A switch selects whether the mill is to be used for milling, or boring and turning operations.

Large illuminated indicator dials with pointers at each end of the crossrail show the amount of feed for each rail head and another illuminated indicator dial shows the speed of the table. To change the rate of feed or the speed of the table, the operator presses the "increase" or "decrease" buttons at one of the control stations and maintains pressure on the button until the pointer on the dial indicates the desired feed or table speed.

When a gear change is necessary the shifting is performed automatically while the pressure is maintained on the button. This type of feed provides infinite adjustment within the given feed range, and the rate may be changed during the cut.

No hand levers are required except for changing the spindle speed on the auxiliary milling head, and adjusting the bars and saddles by hand.

Diesel Towboats

One of seven new Diesel-powered river towboats being built by Dravo Corp., Pittsburgh, Pa., for operation in the Pittsburgh area coal trade was launched recently into the Ohio River at Dravo's Neville Island Shipyard.

The vessel, a 108-ft, twin-screw barge pusher, was christened the "Crucible."

The boat will operate between the firm's coal mine at Crucible, Pa., and its plant at Midland.

Two of the other boats are for Pittsburgh Consolidation Coal Co., and two are for Jones & Laughlin Steel Corp. United States Steel Co. and Island Creek Fuel & Transportation Co. will get one each.

The new boats will replace some of the picturesque old steam sternwheelers that

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have been mainstays of Pittsburgh's vital river coal traffic for nearly a century.

The Crucible is powered by two Superior Diesel engines, each rated at 533 hp. The boats normally will handle six barges loaded with a total of 5400 tons of coal.

For improved "push" and maneuverability, the twin propellers are housed in Dravo Kort Nozzles. A steel ring of airfoil cross section, the Kort Nozzle guides large quantities of water to, through, and away from the propeller enabling it to take a bigger "bite."

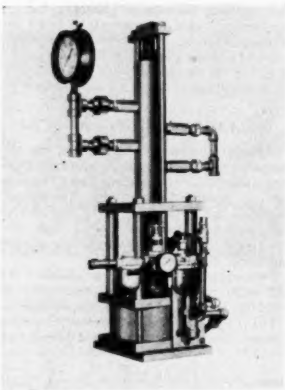
Main engine controls are at the pilot's fingertips, giving him virtually the same control over the vessel as a motorist has with his auto.

Reversing gears on the Crucible enable engines to remain running in one direction, thus eliminating the necessity for stopping the engines to reverse.

Crew quarters on the Crucible consist of seven cabins. The galley is as up to date as any modern kitchen, containing a stainless-steel range and cabinet sink, large refrigerator, and a food freezer.

Equipment on the boat includes a radar system that permits navigation through fog.

Hydro-Pneumatic Pump



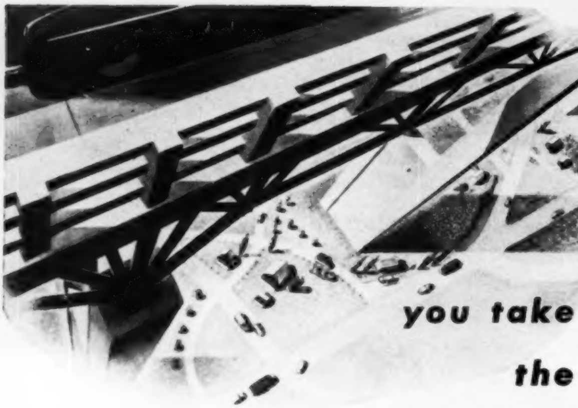
The Aldrich Pump Co., Allentown, Pa., has recently completed design improvements on the Aldrich-Lytle Hydro-Pneumatic unit. This pump is self-contained, uses normal plant air as the power medium, and provides high pressures (up to 20,000 psi) at small volume. The unit has been made more compact, lighter in weight, and incorporates other refinements in design. Its use in testing tubing, valves, and pressure vessels, in the operation of small molding presses, and in other services requiring high pressure at small volume, has proved highly satisfactory.

Cathode-Ray Oscillograph

The Type 294 Cathode-Ray Oscillograph, a product of the Instrument Division, Allen B. DuMont Laboratories, Inc., is especially designed for accurate study of pulse waveforms.

The Y-axis amplifier of the Type 294 Cathode-ray Oscillograph has been designed with extreme care so that an input-pulse rise-time of 0.01 microsecond will be reproduced with a rise time not exceeding 0.03 microsecond, while the general purpose utility of

Continued on Page 46



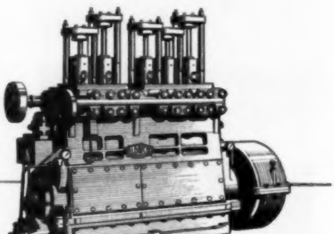
you take the high road

It's the short way home . . . when the high road means a straight line and a through-flow of traffic. It means too that you can get more work done today . . . and still more tomorrow.

Designed to give virtually the same results, the Aldrich Direct Flow Pump passes liquid directly through the working barrel. Aldrich design engineers have successfully eliminated two right angle turns in the fluid-end block.

The design, resulting in a reduction of "loss space", means more work done at less cost. Volumetric efficiency is improved and materials are saved. In each size, you get a lighter, more compact pump that does the same work better . . . which is why more people are coming to Aldrich for pumps made in 3", 5", 6" triplex; 5", 6" quintuplex and 5", 6" septuplex units . . . to meet medium-to-high pressure and capacity requirements.

Applications where Aldrich Direct Flow Pumps are operating today include: hydraulic systems for press operation; plastic and rubber molding and extrusion; steel mill descaling, and other uses in the petroleum and chemical industries. Request Data Sheet 64.



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the instrument is extended to operation at sinewave frequencies beyond 20 megacycles.

The deflection capacity of the Type 294 provides 1.7 in. of undistorted deflection for unidirectional pulses, and 3.4 in. for symmetrical signals. Thus, in addition to insuring faithful reproduction of waveforms, full advantage is taken of the usable scan of the instrument's cathode-ray tube.

The Du Mont Type 5XP- High-Voltage Cathode-Ray Tube is operated at 12,000 volts making possible the fast sweep speeds necessary to display transient pulses of exceedingly short duration and insuring sufficient light output to record such transients with an oscillograph-record camera. For applications where additional sensitivity and deflection is advantageous, the accelerating potential may be lowered to 7000 volts simply by means of a rear-panel switch.

Recurrent sweeps variable in frequency from 10 cps to 150,000 cps, and driven sweeps variable in duration from 0.1 sec to 2 microseconds, are provided in the Type 294. A maximum sweep-starting time of 0.15 microsecond and a signal delay of 0.25 microsecond insure full display of steep-wavefront pulses. In conjunction with driven-sweep operation, external circuits may be initiated by a trigger generated and supplied by the Type 294.

Timing markers, particularly valuable when making permanent photographic records, are provided in intervals of 1, 10, and 100 microseconds. The Type 294 is equipped with a Du Mont Type 2501 Bezel for mounting either the Du Mont Type 314-A or Type 271-A Oscillograph-record Camera.

SR-4 Differential Pressure Cell

Differential pressure cells based on SR-4 resistance wire strain gage measurement have been added to the Baldwin-Lima-Hamilton line of standard products. These cells, identified as Type FMB, are interchangeable, precision products having high accuracy, with full compensation for temperature and linear acceleration.

Two pressure ranges are available: ±10 and ±20 psi. Maximum permissible line pressures are 50 and 100 psi, respectively.

The Type FMB SR-4 differential pressure cell consists of a pair of matched Monel metal

pressure bellows arranged to apply opposing forces on a cantilever beam to which SR-4 strain gages are bonded. The sensing element is hermetically sealed by solder in an aluminum box. Electrical connections are made through glass-to-metal seals. The cell is insensitive to linear acceleration in any direction and may be mounted in any position without affecting pressure indications.

Differential cells are designed for the standard 120-ohm circuit and for 300-ohm circuits. Recommended input voltages are

• Keep Informed

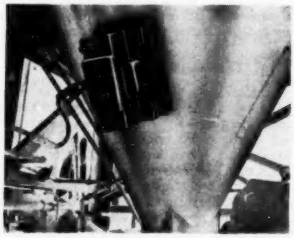
6 volts and 12 volts respectively with maximums of 8 and 16 volts respectively. Output at rated differential pressures is 2.000 ± 0.005 millivolts per volt input. Cells are temperature compensated for zero and span. Calibration accuracy is within 1/4 per cent of full scale anywhere within the rated range.

In addition to differential measurements of fluid and gas pressures, the cells may be used for measurement of flow, liquid level, and other purposes such as determination of airfoil pressure distribution in wind tunnel tests. They may be used with standard Baldwin and other indicating, recording, and controlling instruments.

Electric Vibrators

The Syntron Co., Homer City, Pa., announces the addition to its line of bin, hopper, and chute vibrators, of seminoiseless models of the larger sizes.

These new seminoiseless vibrators perform the same function as the standard models, with a sharp reduction in the operating noise, making them especially useful on interior bins, hoppers, and chutes where large numbers of employees are working. The reduction in operating noise is due to a design change in which the metallic striking parts have been eliminated and rubber bumpers substituted therefore.



The new seminoiseless vibrators are available in four models, with capacities ranging for use on small hoppers containing as little as 20 cu ft of material up to Bunkers holding hundreds of tons for operation from 110-volt, or 220-volt, or 44-volt, a c.

They are all furnished with the Syntron variable vibration controller by means of which the intensity of vibration can be regulated to suit the material being handled.

Transition Relays and Speedometer Testing Equipment

New equipment for testing speed-sensitive devices on Alco-GE road locomotives has been announced by the General Electric Co. The equipment consists of a portable axle-generator drive unit and a portable tachometer-frequency indicator.

Designed to speed up locomotive maintenance operations and to help insure proper operation of speed-sensitive devices, the test equipment aids in the accurate setting of automatic-transition relays and overspeed relays, and checks the accuracy of speedometers and the sequence of contactors and speed-sensitive relays.

One man can operate the equipment, and the control and meter can be placed next to the equipment being tested.

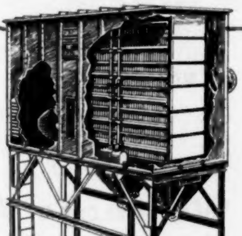
The portable axle-generator drive (Model 17MM14B1) drives the locomotive axle generator at controlled speeds, by means of 75 volt d-c motor, a rheostat, a mounting and

Continued on Page 48

* At the Kellogg Company of Battle Creek, Mich., this Pangborn Dust Control system salvages 35 tons of valuable dust per day. Collected from the corn mill and the Gro-Pup building, the dust is valued at $40 a ton . . . building a profit of *$1400 a day* for Kellogg!

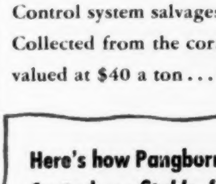
Here's how Pangborn makes Dust Control *profitable* for industry!

Pangborn Dust Collectors make low-cost dust control possible. As this cutaway shows, type "CH" Collectors are compact, offer maximum filtering area in a given size. Filter life is prolonged because dust-laden air passes through collector at low velocity. Efficiency is extremely high; in fact, clean exhausted air can often be returned direct to plant.



FIND OUT how Pangborn Dust Control *turns dust into profits.* Write for a copy of Bulletin 909A to: PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Maryland.

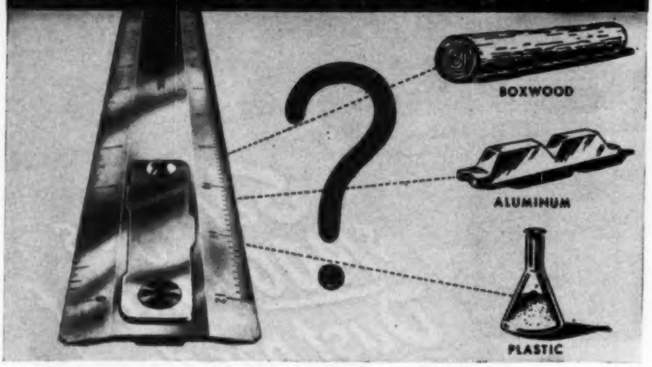
Look to Pangborn for the latest developments in Dust Control and Blast Cleaning Equipment



P THE DUST HOG from stealing profits with Pangborn DUST CONTROL

as an engineer –

WHICH MATERIAL WOULD YOU CHOOSE FOR A *LIFETIME, PRECISION DRAFTING MACHINE SCALE?*



Problem factors-

ACCURACY—

Is material machinable to precision tolerances? Is material stable —will machined accuracy last?

DURABILITY—

How will material stand up? Will it warp, chip or peel? Will material hold a true, smooth ruling-edge? Will the finish withstand abrasion of grit and paper?

READABILITY—

Will the material take a clear, high-contrast permanent finish? Will the finish eliminate glare-light—the cause of eye-strain?

UNIFORMITY—

In the manufacturing process, will the material hold precision tolerances that will allow uniformity of line length and depth of number impression?

Will the material insure that one scale will match any other scale —at any time?

We chose ALUMINUM—for the new DURALINE SCALE

Duraline scales have the advantage of boxwood scales—readability. They have none of the many disadvantages—they remain accurate—won't shrink, warp, peel, or chip. Duraline has also eliminated the disadvantages of previous aluminum scales—will not glare, file pencil point or smudge paper. And Duralines are priced lower than boxwood scales. Order from your dealer now—or write us. Literature on request.

UNIVERSAL DRAFTING MACHINE CORPORATION

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DRAFTING MACHINE — DURALINE SCALES

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carrying frame, and leads which connect to the locomotive battery circuit. The mounting frame is designed for attaching the drive unit to generator models 5GYA3A1 or 5GYA17A1. The drive unit is connected by removing the small end cover from the generator, removing the spline shaft connecting the generator to the axle, and inserting the spline of the drive unit. The unit weighs only 60 lb and is equipped with a carrying handle.

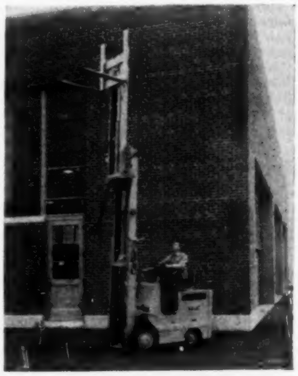
Besides its use with the automatic-transition-type axle generator, the drive unit can also be used to drive the small axle-generator (Model 2CM4J7) which operates a speedometer only, when the locomotive is not equipped for automatic transition. In this case the axle generator is removed from the drive journal box cover and mounted on the unit.

The portable tachometer-frequency indicator (Model 8943485G1) is an electric frequency meter which was developed especially for this test equipment. A cycles-per-second scale provides information for accurately setting the automatic-transition relays. The instrument is easily calibrated by means of a switch and calibrating screws, after plugging into a 60-cycle, 115-volt outlet.

A dual-purpose instrument, the tachometer-frequency indicator also indicates engine speed by reading the output of engine tachometers. The unit is adaptable for both old and new locomotives, with or without plug receptacles on the engine control panel.

Telescopic Lift Truck

A design innovation that permits standard 83-in. over-all height telescopic lift trucks to "reach for the sky" and tier loads in greater than 16-ft stacks was announced by the Philadelphia Division of the Yale & Towne Mfg. Co. This new development will enable distribution and transportation companies as well as industrial concerns to utilize to the full available storage space now considered critical both from a cost and availability standpoint.



The new device consists of an extra set of front channels and an additional lifting cylinder. The channels are hung directly in front of the regular telescopic channels and are operated by a separate control. This extra attachment can be quickly removed for normal fork-truck operation.

In other respects, trucks equipped with this device are standard Yale gasoline or electric trucks.

Here's a fund of knowledge to help you

DEFENSE production spells tougher materials and new materials such as high temperature alloys and super stainless steels. Such metals and the tolerances and finishes required by Armed Services specifications bring new problems to plants experienced in civilian production.

D. A. Stuart Oil Co. has a tremendous backlog of experience in helping solve defense machining problems through correct application of the proper cutting fluids.

This fund of information, preserved and developed, is available to help you if you are engaged in defense work.

Use Stuart as your clearing house for helpful information.

WRITE TODAY, or call our nearest office outlining your specific problems.

D.A. Stuart Oil CO.

2741 S. Troy St., Chicago 23, Ill.

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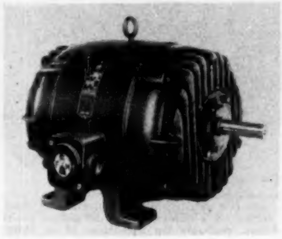
Squirrel Cage Induction Motors

Fairbanks, Morse & Co., Chicago, Ill., have recently extended their line of type QZE, totally enclosed, nonventilated, squirrel cage, induction motors to include continuous duty ratings built in NEMA standard frame 284. At present, $7^1/_2$-hp, 1800-rpm, and 5-hp, 1200-rpm motors are in production.

These motors conform in all respects to NEMA and ASA standards for totally enclosed machines, and are identical in mounting dimensions with standard totally en-



closed, fan-cooled motors of the same ratings. They are suitable for service in adverse locations where dirt, dust, lint, metal turnings, and sand are prevalent, since there are no ventilating openings to clog.

Rotors are the Fairbanks-Morse "Copperspun." Ball bearings are of the cartridge type with ample grease space to permit sealing for the life of the bearing if desired, but with provisions for easy flushing and regreasing. Conduit boxes are the Fairbanks-Morse dual type.

Bulletin 1215 gives further information.

Strong Weld

A weld when made rigid is as strong or stronger than the plate in which it is made, according to Lincoln Electric Co., Cleveland, Ohio. For example, when a mile of this 30-

in. pipe line exploded, the welds, both longitudinal and circumferential, held while the plate tore apart as if cut with shears. The solid welds can be clearly seen in the section of pipe in the top of the picture.

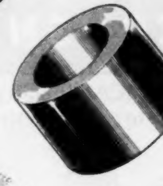
Automatic Unloading Attachment

A new, low-cost, universal, self-contained, automatic unloading attachment for rotary gear shaving machines has been introduced by Michigan Tool Co., 7171 E. McNichols Road, Detroit 12, Mich.

The attachment supplies the need for a standard unit available at low cost to convert shaving machines for automatic unloading. It is especially adaptable to unloading of small gears when automatic loading is employed. Use of the attachment

Continued on Page 50

WORKS WHERE OTHERS WON'T



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SELF-LUBRICATING • EXTREMELY DURABLE • CONSTANT CO-EFFICIENT OF FRICTION • OPERATES DRY — OR SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS • APPLICABLE OVER A WIDE TEMPERATURE RANGE — *even where oil solidifies or carbonizes* • EXCELLENT AS A CURRENT-CARRYING BEARING.

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from TEST GRINDING to TONNAGE CRUSHING

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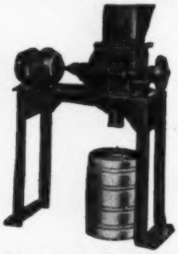

AMERICAN Laboratory Size Mills
With the same reduction action as Metal Turnings Crushers (or hammer action)—American Laboratory Size Mills offer an efficient means for reducing razor blades, pewter castings and fragile, thin brittle steel to a reclaim product.

AMERICAN Metal Turnings Crushers
Bulky, hard-to-handle turnings are rapidly reduced as much as 80% with this efficient, economical crusher. And the yield of cutting oil is increased 30 to 50 gallons per ton—proof of how profitable the installation of an American Metal Turnings Crusher can be for those who handle 20 tons or more of metal turnings a month.

There's a custom-built AMERICAN for your operation—write for further data and specifications.

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

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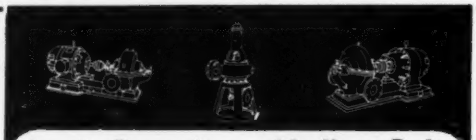


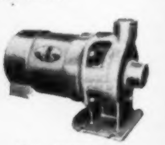
Small Capacity • Medium Duty
SIDE SUCTION PUMPS

Close-Coupled • Flexible Coupling • Belt Drive

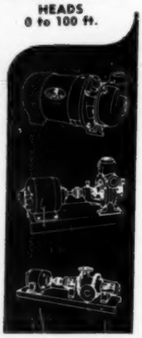
CAPS 5 to 75 G.P.M.

HEADS 0 to 100 ft.

Ideal as part of Equipment Manufacturer's product, such as, air conditioning units, cooling towers, evaporator coolers, milk coolers, hot water circulators, etc. — and general service. Speeds 1750 to 3500 R.P.M.



Type JMC Aurora Close-Coupled Pump



DISTRIBUTORS IN PRINCIPAL CITIES

AURORA Always PUMPS

AURORA PUMP COMPANY

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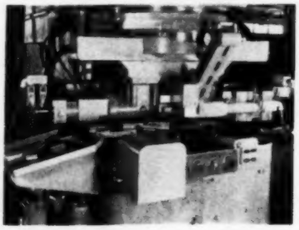
cuts costs by reducing operator fatigue and permitting one operator to service more machines.



A typical application of the unloader is shown in the illustration; guards have been removed from the machine for clarity. The unloader consists of a small wire-mesh belt which travels over two drums. Drive is from a low-horsepower electric motor; slots in one mounting bracket allow adjustment to take up slack in the belt.

Advantages in the use of a wire-mesh belt are as follows:

1 Since the belt moves at a relatively low constant speed, it permits cutting fluids to drain back into the machine before the gear is discharged into the collecting pan.

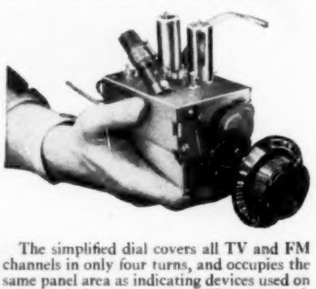
2 The belt has a certain amount of give which prevents damage to the finished gear either from striking a conventional metal chute or another gear. (Metal in the belt is softer than the gears.)

3 Long life expectancy of the belt; freedom from damage from cutting fluid.

The unloader can be quickly attached to any Michigan Tool Co. 870 or 870A automatic gear finisher in any of several positions. No changes in the machine are necessary except to drill and tap a few holes for mounting brackets and the discharge chute.

Detent-Action Inputuner

One-knob quick-click tuning of TV channels yet retaining the continuous tuning feature for critical on-the-button reception of TV plus FM programs, distinguishes the new Series T3C Du Mont Inputuner. Announced by the Electronic Parts Division of Allen B. Du Mont Laboratories, Inc., East Paterson, N. J., the new unit is a ready replacement, both mechanically and electrically, for the majority of switch-type tuners.



The simplified dial covers all TV and FM channels in only four turns, and occupies the same panel area as indicating devices used on most switch-type tuners. The one-knob operation simply clicks into any TV channel and then fine-tunes for superlative results.

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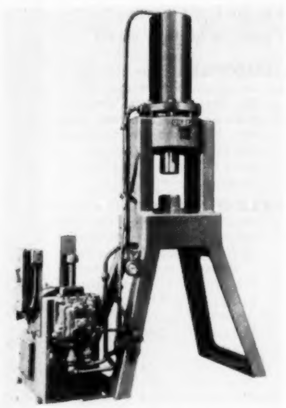
The Du Mont Series T3C (jobber model, with dial) or Series T3B (manufacturer's model) utilizes the Mallory-Ware 3-gang spiral Inductuner plus antenna tuning which provides 4-circuit performance without extending the physical length of the chassis. The 6BC5 pentode RF stage with tuned input provides maximum sensitivity. The RF stage is over-coupled to the 6J6 mixer-oscillator for wide band-pass. A mixer plate network is available to match the IF system of most TV chassis. The Inputuner is ready to install—just tune mixer plate coil and sound trap (if provided) for IF system of associated TV set.

Dimensions: $4^{61}/_{64}$ in. L, $3^{3}/_{32}$ in. W, $5^{5}/_{64}$ in. H, Shipping weight, 4 lb. Available in four models, viz., aligned for sound center IF of 21.25 or 21.75 mcs, with or without sound trap.

Extruding Ceramics

Designed essentially for extruding ceramics, Oilgear Co., Milwaukee, Wis., special 50-ton two-column vertical press is also ideal for extruding graphite, pencil leads, crayons, etc. Table is 60 in. high to accommodate recepticle for extruded product. Dual hand levers with spring detent permit control of press ram from two positions. An Oilgear feed pump provides positive, steady, fine, variable ram speeds essential for the extrusion of small ceramic parts and also provides rapid closing and return speeds to cut down the cycle time and congealing of materials.



In operation, either control lever is moved to rapid traverse position to bring ram downward at 58 ipm. As ram reaches extruding cylinder, either lever is tripped to feed position and ram continues downward at speeds variable from 0.07 ipm to 2.5 ipm. When the desired stroke is completed, either lever is tripped and ram moves upward at 64 ipm. When ram reaches the desired up position, either lever is moved to neutral and ram stops. Any ram function can be selected at will. Stroke, $26^{1}/_{2}$ in., daylight, $18^{1}/_{2}$ in., between columns, 18 in., front to back 24 in., net weight 6250 lb.

Flexon Bellows

Flexon Bellows as manufactured by Chicago Metal Hose Corp. are available in a complete range of sizes and metals. They are manufactured of brass, stainless steel, bronze, monel, and inconel in single and multiple-ply construction and in various lengths, dependent upon the application requirements. They are specially suited for applications of control devices and instrumentation; such as regulators, valves, steam traps, shaft seals, expansion connections, and flexible connectors for misalignment.

For further information write Chicago Metal Hose Corp., 1316 S. Third Avenue, Maywood, Ill., and request a copy of their Bellows Catalog CMH-113.

Centrifugal Pump

The sixth 22,500-hp centrifugal pump has been delivered to the U. S. Bureau of Reclamation project at Tracy, Calif., by Worthington Pump and Machinery Corp., Harrison, N. J., thus completing that contract. The pump contract was awarded in June, 1946, and shipments started in September, 1949.

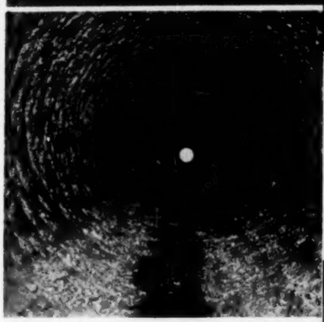
The pumps will give a 200-ft lift to water from the Sacramento River, sending it into the 120-mile Delta Mendota Canal to irrigate farms in the San Joaquin Valley.

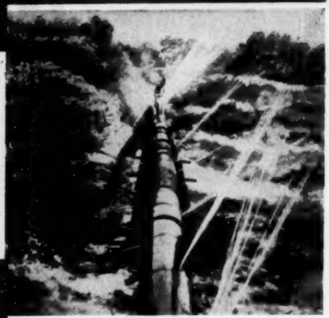
Each pump is rated at 767 cfs at a 200-ft pumping head. The completed plant will be able to pump nearly 3 billion gal every 24 hr. In 30 min the six pumps, driven by 135,000 hp will handle more water than the City of Sacramento consumes during an average day.

To house these pumps, the world's second largest pumping plant had to be constructed at Tracy in an excavation larger than Boulder Dam. The project was started in Octo-

Continued on Page 52

Stop Pipeline Corrosion and Leakage with CENTRILINE





Corrosion and leakage are effectively controlled when pipelines are cleaned and cement lined by Centriline. Note these important features of Centrilining:

1. Work is done *mechanically*—1000′ per day and more.
2. Cost is a *fraction* of that for new pipelines.
3. Pipeline remains *underground*—minimum disturbance to operations.
4. Temporary *by-pass service* provided where necessary.
5. EXPERIENCE—over 2,500,000 lineal ft., in cast iron, steel, & concrete pipe, in *4″ to 144″ diameters.*
6. Applicable to fresh or salt *water,* oil, sewage, gas and industrial *waste* lines.
7. Work complies with pertinent A.W.W.A. specifications.
8. ADVANTAGES: Permanently increases carrying capacity; Raises distribution pressures; Reduces pumping costs; Stops leakage at joints or where pitted; Lengthens pipe life; Saves water; Eliminates water discoloration; Reduces maintenance costs.

CENTRILINE CORPORATION

A subsidiary of ® Raymond Concrete Pile Co.

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Branch Offices in Principal Cities in the United States and Latin America

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American Pipe & Construction Company of Los Angeles, Calif. (P.O. Box 3428, Terminal Annex) Licensee Western Part of U. S.

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ber, 1947, and it is expected that some units will commence operation the first part of 1951.

Impactor Cross-Arm Handle

A new cross-arm handle incorporating the Edward impactor handwheel principle has been announced by Edward Valves, Inc., East Chicago, Ind.

The Edward impactor cross-arm handle, which is a means for exerting greater effort to positively close a valve against high operating or test pressures, delivers 2.8 times the closing force of regular handwheels.

The new impactor handle is applicable to many small Edward valves. It is ideally suited, however, for $1^1/_4$, $1^1/_2$, and 2-in-size Edward Univalves of 1500 and 2500 lb sp and 2-in-size Edward hydraulic valves. Application of the new Impactor handle in additional progressive sizes is being made available.

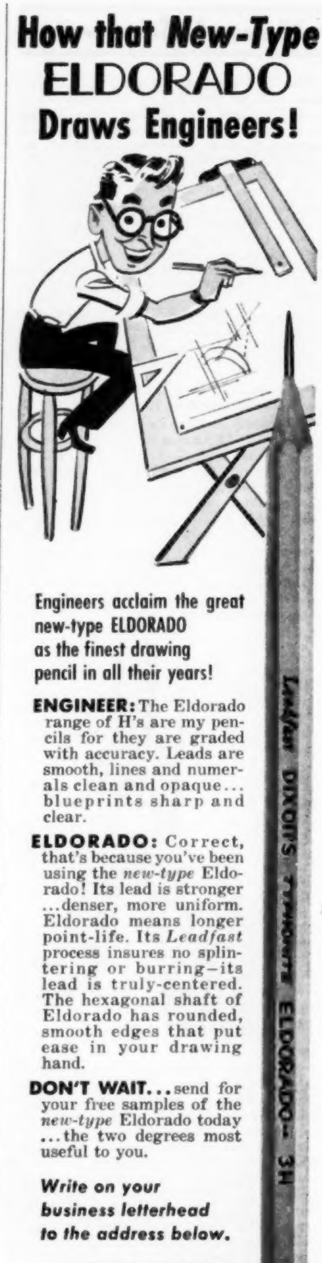
In operation, two lugs of the cross-arm handle strike equal blows simultaneously against the opposite sides of the small adaptor, which is permanently attached to the valve stem. Wrenches or extension bars are not needed to deliver this extra force.

The handle is cast malleable iron with neatly shaped contours for a comfortable, sure grip. The stem adaptor is drop-forged steel.

Short-Circuit Tests

A new record for short-circuit current was set recently during a series of tests conducted by the General Electric Co. and the U. S. Bureau of Reclamation at Grand Coulee Dam. The tests were made on a single-pole unit of one of the thirteen 10,000,000-kva, 230-kv low-oil-content impulse type oil circuit breakers now installed in the Right Hand Switchyard of the Grand Coulee project. The generating capacity of twelve of the fourteen 108,000 kw generators at Grand Coulee plus the available capacity of other stations of the Northwest Power Pool were thrown into the tests to produce the largest value of short circuit current ever recorded—the equivalent of 12,000,000 kva symmetrical three phase.

V. L. Cox, manager of engineering of General Electric's Switchgear Divisions reports that even this enormous amount of short circuit current was interruprted by the 10,000,-000-kva circuit breaker unit within its rated



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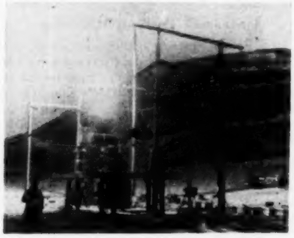
interrupting time of 3 cycles without any sign of distress.

According to Mr. Cox, a total of 12 interrupting and 24 line dropping tests were made, all of which were entirely successful. The interrupting tests ranged from 5,000,000 to 12,000,000 kva and four of them, ranging from 6,000,000 to 9,000,000 kva were high-speed reclosing tests with reclosing times between 8.75 and 9.2 cycles. The line dropping tests, all of which were accomplished without the occurrence of a single restrike, were made with from 100 to 300 miles of 230-kv transmission line.



The test breaker was not opened up for inspection or part replacement during the entire series of tests but careful inspection afterward revealed that all parts of the breaker were in condition to continue normal operation and the unit could have easily withstood many additional tests of like magnitude.

An elaborate instrumentation equipment devised by the General Electric Company's Switchgear Divisions' Laboratory was used to provide records of the tests in much more complete form than has been possible on any previous field test of this nature.

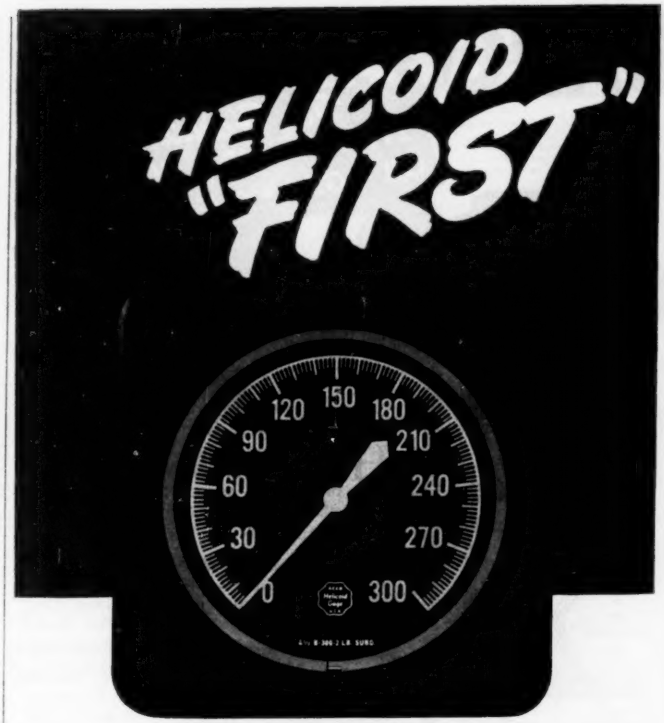
Motor Starter

Protection of operating personnel as well as the connected machine is stressed in a new motor starter—the Motor Watchman, Class 10-100-S1—available from Westinghouse Elect ic Corp.

With ratings up to 600-volts, 7½-hp polyphase, 5-hp single phase; or 220-volts, 1½-hp d-c it starts, stops, and provides overload protection for single phase, polyphase and d-c motors.

The self-indicating handle, interlocked cover that prevents opening unless starter is

Continued on Page 54



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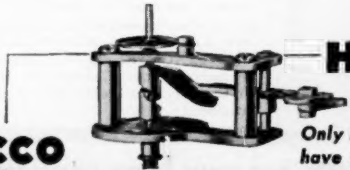
- illuminated dial with black light just like airplane or automobile panel instruments for better visibility without glare
- also available with white light and with black or white dials
- ideal for symmetrical panel layouts
- dial sizes 4½", 6" or 8½"—all standard pressure ranges

Write for complete information



HELICOID

Only Helicoid Pressure Gages have the Helicoid Movement

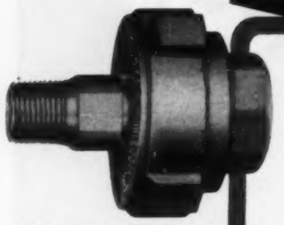
ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut

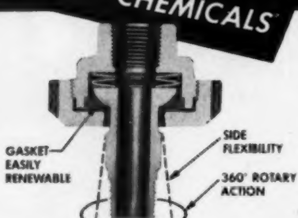
TRADE MARK

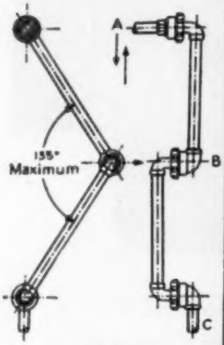
BARCO *Flexible Rotary* SWIVEL JOINTS

For Handling
STEAM • AIR • WATER
OIL • GAS • CHEMICALS



Model SA-7S-8CS — Industrial Type Swivel Joint. Sizes ⅜" to 2".





A TYPICAL APPLICATION—To provide a piping connection from Point A (moving) to Point C (fixed). Install joint at A with axis normal to plane of motion of A. Install joints at B and C with axes parallel to axis of joint at A. Locate joints in plane parallel to plane of motion of A.

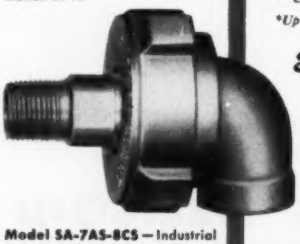
HERE'S how to make piping connections to steam jacketed tilting kettles, press platens, low speed* revolving drums and rolls, and other moving equipment — *Use Barco Flexible Swivel Joints!*

FOR BETTER ENGINEERING! Put flexibility where you want it — without the nuisance of sagging, flopping, non-rigid lines. Easy to position lines accurately for good drainage and good temperature control.

NO BINDING — LOW TORQUE! Barco's *exclusive* design provides for side flexibility — takes care of inaccurate pipe alignment, prevents binding. Where required, joints can be supplied without side flexibility.

PRESSURE SAFE! The seal will not break or blow out suddenly. High temperature and fire resistance. No swelling or expansion under pressure. Built for pressure ratings as high as 3,000 p.s.i., or higher under certain conditions. No leakage under varying conditions of vacuum and pressure. Joints function perfectly at extremely low and high temperatures.

**Up to 30 RPM. For higher speeds, use Barco Revolving Joints.*



Model SA-7AS-8CS — Industrial Type Swivel Joint for angle connection. Sizes ⅜" to 2".

Engineering Recommendations

Barco factory and field engineers will be glad to help you solve your problems. Wide choice of styles and sizes available from ⅛" to 2". Gasket materials to meet user's particular requirements. *Ask for new Catalog No. 265.* BARCO MANUFACTURING CO., 1821F Winnemac Ave., Chicago 40, Ill. In Canada: The Holden Co., Ltd., Montreal.

BARCO THE ONLY TRULY COMPLETE LINE OF FLEXIBLE, SWIVEL, SWING, AND REVOLVING JOINTS

Worldwide Sales and Service

FREE ENTERPRISE — THE CORNERSTONE OF AMERICAN PROSPERITY

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"off," and safety latch to lock starter "off" during servicing are personnel-protection features.

Positive motor protection is provided by the quick-make, quick-break, over-center toggle mechanism—De-ion arc-quenching—and the bimetallic disc-type thermal overload relay.

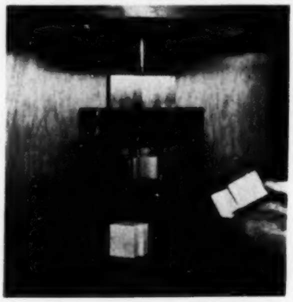
Straight-through wiring is designed to facilitate installation and servicing, and Bonderized enclosures prevent blistering, flaking and corroding.

For further information, write the Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Universal Testing Machine

In quality-control studies of glues and wood joints, a leading part is taken by this Baldwin universal testing machine in the research laboratory of Timber Engineering Company, Washington, D. C. High accuracy is required in testing glued joints in order to meet A.S.T.M. specifications.

The machine is always a center of activity when the company holds its periodical, five-day gluing school. One of its jobs then is to compare the efficiency of homemade shear-testing machines and to calibrate them for testing small standard shear-test specimens. The school is open to representatives of any company interested in improving its gluing methods or glues.



In the test being demonstrated, a standard block shear tool is used in the testing machine. Standard shear-test specimens are made of hard maple having a specific gravity of 0.65 to 0.71. Blocks are $2 \times 1^3/_4 \times ^3/_4$ in., two being glued together with a joint area of 3 sq in., leaving $^1/_4$-in. overhangs on the 2-in. ends. If the glue is strong enough the block will shear through the wood adjoining the plane of the glue surfaces. Shear blocks bonded with modern resin adhesives frequently develop strengths exceeding 4000 psi.

To meet all load requirements with maximum accuracy, six load ranges up to 0–200,000 lb are provided by the two 24-in-diam dials. The 0–20,000-lb range, for example, would show approximately 20 lb for each $^1/_{16}$-in. of scale.

Channel Marking Machine

The CM-50 channel marking machine has been developed by M. E. Cunningham Co., Pittsburgh, Pa., for stamping trade name, address, or other identification on aluminum or other metal channel sections. Although developed specifically for code identifying aluminum storm doors and windows, this equipment also can be produced for stamping small steel or aluminum channel sections of practically any shape.

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A channel section is marked by pulling the handle from left to right. This action rolls a deep, clear-cut mark in the channel without distorting the metal. A spring returns the mandrel to position for the next marking.

The roll die can be made with lettering engraved on the solid roll. For part numbers or other changing identification marks, interchangeable type set-ups can be provided.

The base or mandrel section is machined to suit individual channel shapes. Mounted on needle bearings, it is made of solid steel for providing a solid stamping surface.

• *BUSINESS CHANGES*

Ladish Opens New Branch Office

Ladish Co., Cudahy, Wis., manufacturer of a complete line of forged and seamless welding pipe fittings has announced the establishment of a branch office at 405–406 Thompson Building, Tulsa, Okla. The office is under the managership of G. E. Mahoney who for the past 3 years has served as district manager for Ladish at Chicago.

Simultaneously Ladish announced a change in address of their St. Louis office and the appointment of W. H. Heckenberg as district manager. The new office address is Suite 1605, Continental Building, 3615 Olive St., St. Louis, Mo.

Foxboro Opens Knoxville Office

A new branch office of The Foxboro Co., Foxboro, Mass., has been opened at 618 W. Church Ave., Knoxville 16, Tenn. Marven L. Cleaton, Jr., formerly in charge of the company's office at Columbus, Ohio, has been transferred to become branch manager at Knoxville. Until now, manufacturers in the Knoxville area have been served by the Foxboro office in Atlanta.

Timken-Detroit Expands Brake Manufacturing

The TDA Brake Division of The Timken-Detroit Axle Co., Ashtabula, Ohio, has launched a major expansion of its industrial brake manufacturing, according to a recent announcement.

This development climaxes many months of preparation in the TDA Brake Division plant and laboratory in Ashtabula. Extensive research and engineering work have been done on a wide variety of industrial brake applications, plus exhaustive field tests and studies.

A highly trained staff will have at its disposal all equipment needed to solve industrial brake problems of every kind. Special-

Continued on Page 56

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Of primary importance, at Nordberg, the Profilometer is used at the spot where it is most valuable—right next to the vertical hone. As in many other plants, it is fully recognized as an important shop tool.

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ized industrial brake applications perfected by TDA have been in service for varying periods of years.

Such equipment as centrifuges, conveyers, cranes, hoists, winches, and many other machines are typical of the industrial applications for TDA brakes. In the automotive field, TDA brakes for such vehicles as trucks, tractors, trailers, busses, and trolley coaches have occupied a preferred position for a generation.

Koppers Chemical Division Expands

Koppers Co., Inc., recently announced a multimillion dollar program of expansion for its Chemical Division which provides for construction of a new plant near Port Arthur, Texas, and additions to its present facilities at Kobuta, Pa.

The program will, within a year, make it possible to increase the Division's production of styrene monomer by approximately 33 per cent, and to increase the Division's production of the popular plastic, polystyrene, by approximately 25 per cent.

At Port Arthur, Koppers will construct a plant which will take ethylene from the unit which Gulf Oil recently announced it will build at its Port Arthur refinery and combine it with benzene to make ethyl-benzene. Ethyl-benzene is used as an intermediate in making styrene, which, in turn, is basic to making synthetic rubber and polystyrene.

Benzene will be transported to the plant and the finished ethyl-benzene will be transported to Kobuta, Pa.

New facilities at Kobuta, Pa., will include those to increase the production of styrene monomer which is essential to the synthetic rubber program. Some increase also will be made in facilities to produce the plastic, polystyrene, from styrene. Koppers has ample land available for this expansion. In addition to the enlarged styrene monomer and polystyrene facilities, a large new warehouse will be constructed.

Carboloy Plant Expansion Program

A $2,800,000 plant expansion program to meet rapidly increasing demand under the defense program for tungsten carbides in various forms has been launched by Carboloy Co., Inc., a General Electric affiliate and world's largest producer of cemented tungsten carbides.

Of the total, approximately $800,000 is being devoted to expanding the present Carboloy plants on 8-Mile Road, Detroit, while $2,000,000 is for construction and equipping of a new plant in Edmore, Mich.

The Detroit expansion will provide approximately 13,000 sq ft of additional production area plus increased facilities for manufacture and storage of hydrogen—used in the sintering of metallic carbides.

Productive area of the new Edmore, Mich., plant will be approximately 45,000 sq ft and will provide employment for approximately 200 when completed. The new plant will have complete tungsten carbide processing facilities—from powder (tungsten, carbon, etc.) to finished products.

In announcing the expansion, it was stated that with completion of the expansion, 50 per cent of Carboloy's carbide metal output will be directly for defense, under government contract, while the other 50 per cent will be indirectly for defense—in the form of carbide tools and dies needed by U. S. industry for the production of equipment for the armed services and essential civilian needs.

Plans for both construction projects have been completed.

• Keep Informed

B & W Tube Co. Adds New Facilities

Better service for users, fabricators, and distributors of B&W stainless tubing as well as increased comfort and effective operation for the company's working personnel has been gained as a result of a new addition to the Beaver Falls, Pa., plant of The Babcock & Wilcox Tube Co. The new facility, an air-conditioned building devoted exclusively to the inspection, marking, packaging, and loading for shipment of stainless tubing, is located at the company's East Works Department

The air-conditioning keeps the atmosphere clean and prevents the accumulation of dust, etc. on the tubing. The floors of the buildings are radiant heated to avert the collection of moisture in the tubes. The lighting above the inspection area is twice as bright as standard industrial requirements, thus helping to insure that only full quality tubing is shipped.

The building itself is completely insulated. The outside walls are sandwich-type corrugated-steel sheeting with fiber glass as the insulating medium. The roof is of steel deck construction, also insulated.

In this new unit specially trained men provide precise and complete inspection. The tubing is marked or identified and packaged in one of several different ways as specified by the customer and then carefully loaded in trucks or railroad cars for shipment. In each step the most scientific methods of handling are employed to insure that the user obtains only the finest quality stainless tubing as required by end use applications in the chemical, petroleum, food, dairy, and drug processing industries.

Petro-Chem Awarded Furnace Contract

Petro-Chem Development Co. has been awarded a furnace contract for a new oil refinery designed by Hydrocarbon Research, Inc., to be built for the National Petroleum Council of Brazil (Cubatao Petroleum Commission) at Cubatao, Brazil.

The contract for ten furnaces to charge a completely integrated oil refinery of 45,000 bbl per day capacity, has been awarded to the Petro-Chem Development Co. of New York, N. Y.

The heaters include the following services: crude-oil distillation, reforming, viscosity breaking, light gas-oil cracking, heavy gas-oil cracking. These heaters are designed for unusually low fuel consumption.

The fabrication work is to be divided between French and American fabricating shops.

G-E Increases Lockland Jet Facilities

The General Electric Co. has announced that its expanded turbojet manufacturing facilities at Lockland, Ohio, would employ more than 10,000 workers, at least a 40 per cent increase over previous estimates.

It was pointed out that previous employment estimates of 7000 workers will be exceeded by 3000 and that total plant facilities will be similarly boosted.

In December, it was announced that General Electric, through purchase, lease, and new construction, was more than tripling the space it has occupied at Lockland for the last two years. This involves construction of an office building and factory buildings, purchase of the "North Shop" which previously had been leased from the Electric Auto-Lite Corp., and the leasing of additional space which now may total more than 1,500,000 sq ft instead of the 1,000,000 sq ft previously announced.

Continued on Page 58

4 things to look for when you need a new black-and-white print machine

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In addition to the leased facilities, the "North Shop" has more than 650,000 sq ft of space. The new office building will have 120,000 sq ft and the factory buildings 300,000 sq ft.

Lockland, the announcement stated, will be fully utilized, in peace or war, and will be one of the world's great jet engine centers. In addition to production facilities, it will be the headquarters for executives and engineering staffs, and for testing and development activities in turbojets and turboprops.

The Lockland plant, where production was started in February, 1949, is being expanded to meet the Air Force's increased needs for the J-47 aircraft jet engine. It augments production by the company's original plant facilities at Lynn, Mass.

Worthington to Occupy New Oil City Works

Sale of the plant and equipment of National Transit Pump and Machine Corp., was completed recently as Worthington Pump and Machinery Corp. took possession of its facilities. The miscellaneous overflow from Worthington's other factories will be diverted here.

Besides pumps, Worthington manufactures Diesel and gas engines, compressors, generators and motors, and equipment for air conditioning and refrigeration, construction and steam power plants. Their operating plants are in Harrison, N. J., Wellsville, N. Y., Dunellen, N. J., Holyoke, Mass., Newark, N. J., Minneapolis, Minn., Buffalo, N. Y., Denver, Colo., and Alhambra, Calif.

The former Transit plant covers 500,000 sq ft, including iron, steel, and brass foundry, pattern shop and forge shop, machine shops and assembly floor, test facilities, powerhouse, steel fabricating shop, and administration building.

Worthington plans to continue to furnish repair and spare parts for the products of National Transit Pump and Machine Co. now in the field.

Baker Appoints Los Angeles Distributor

Baker Refrigeration Corp., South Windham, Maine, announces the appointment of the Baker Engineering Corp., Los Angeles, Calif., as distributor for its full line of air conditioning and refrigeration equipment, effective immediately.

Although Baker Refrigeration Corp. is retiring from direct consumer sales and contracting in this area, the company announced that it will continue to maintain a warehouse stock and district office at 351 South Anderson St., here, to serve its distributors and dealers and the trade. This will remain under the direction of C. E. Hollingworth, district manager, and is staffed by factory-trained engineering and service representatives.

B & W Tube Co. Appoints Denver Sales Agent

The appointment of David W. Jones, Jr., of Denver, Colo., as sales agent for The Babcock & Wilcox Tube Co. in the Rocky Mountain area was announced recently.

In making the announcement a company spokesman said that Mr. Jones' technical training at Lehigh University (1938) and sales experience with Carnegie-Illinois Steel Corp. particularly suited him to handle the sale of B&W's wide range of seamless and welded, carbon, alloy and stainless steel tubular products in the expanding industrial areas in the Rocky Mountain territory. He will maintain his headquarters at 2600 Forest Ave. in Denver.

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Elmira Chosen for Westinghouse Electronic Tube Headquarters

The headquarters plant and engineering laboratories of Westinghouse Electric Corp. new Electronic Tube Division will be located on a 100-acre tract four miles northwest of Elmira, N. Y., it was announced recently.

The plant will produce electronic tubes for the military services and for defense industries. It will provide 1000 new jobs, with most employees coming from the city of Elmira.

Two complete factories will be in a brick one-story manufacturing building containing approximately eight acres of floor space, or six times as much area for the manufacture of electronic tubes as is now available in the company's Lamp Division headquarters plant at Bloomfield, N. J. A two-story brick building in front of the manufacturing building will house the administrative offices, sales offices, and engineering laboratories, where new tube design and advanced development work will be done.

If military requirements drop off, the electronic tube plants will be converted—and rebuilt if necessary—for the manufacture of commercial tubes for radio and television transmitting and receiving, and tubes for industrial and x-ray use.

Completion of construction work is scheduled for early next fall.

Allis-Chalmers Opens Peoria Office

Stanley E. Bovim has been named manager of a new branch office of Allis-Chalmers' general machinery division in Peoria, Ill.

F. D. McGuire, Jr., has been transferred from the Chicago district office to the new Peoria branch as sales representative.

Westinghouse Builds New Lamp Warehouse

Purchase of $3^1/_2$ acres in Farmers Branch, Texas, which is near Dallas, for construction of a warehouse having room for nine million light bulbs has been announced by Frank C. Cline, manager of the Southwestern District, Westinghouse Lamp Division.

The warehouse will expedite delivery of light bulbs to expanding defense industries in Texas and nearby states, vital areas in this nation's line of defense, Mr. Cline said. Texas customers now are being served by the Company's light-bulb warehouses in St. Louis, Mo., and Little Rock, Ark.

It is the second major Westinghouse construction project announced in Texas within the last few months. Construction of a new light bulb manufacturing plant in Paris, Tex., now is underway.

• LATEST CATALOGS

Oil Burners

A new condensed, 16-page catalog, in color, has been issued by Ray Oil Burner Co., 401–499 Bernal Ave., San Francisco 12, Calif. Catalog gives a complete listing, with illustrations, of the company's oil-burner products including; fully automatic horizontal rotary type; steam-turbine-driven type; combination gas-oil type; semiautomatic type, and pressure-atomizing type. Booklet also features a unique selector chart, plus listing of specifications and capacities. Operation and control of each unit is described in detail.

Metallurgical Research Findings

The Lunkenheimer Co., Cincinnati, Ohio, has available two comprehensive brochures describing Lunkenheimer Cast Steels and Copper Base Alloys, which will help solve piping problems and conserve critical materials by getting maximum service from equipment. This metallurgical information deals with the basic problems of metal soundness, porosity, welding, graphitization, creep strength, new alloys, code conformance, and other subjects, and is the result of Lunkenheimer's years of research. The brochures are available from the Lunkenheimer Co., Box 360-AA, Cincinnati 14, Ohio.

Pyrometer Equipment

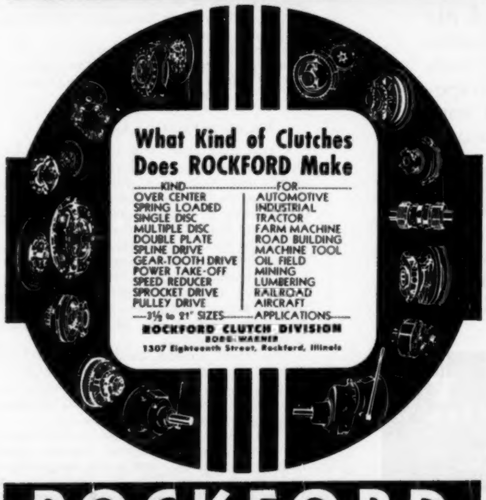
New pyrometer equipment, which offers accurate temperature indication, close temperature control of industrial processes and protection for furnaces, ovens and kilns, is described in Bulletin GEA-5534, and is available from the General Electric Co. Meter and Instrument Divisions, Schenectady 5, N. Y.

The complete line consists of flush or surface-mounted indicators, controllers, and protectors.

Designed for industrial applications that include heat-treating furnaces; brick, cement or ceramic kilns; melting furnaces, cooking kettles, plastic molding machines, impregnating tanks and cloth-treating ovens, the instrument has a calibrated accuracy within $^3/_4$ of 1 per cent of full scale. A legible 7-in. scale, fitted with an antiglare cover, indicates any change in temperature equivalent to $^1/_{10}$ of 1 per cent of full scale.

Continued on Page 60

CONTROL POWER BETTER



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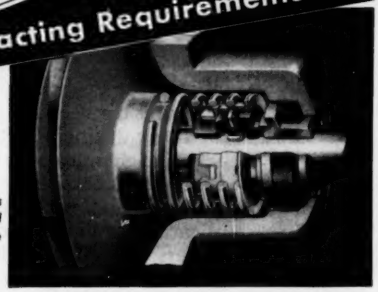

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Our trained field engineers are ready to work with you in selecting the best "John Crane" seal for your needs.

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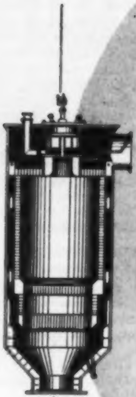

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Strainalyzer

Bulletin 331, 2 pages, describing the H-42A Strainalyzer, is announced by Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. The instrument, used in conjunction with Baldwin SR-4 resistance wire strain gages, is designed for dynamic strain and vibration studies from 0 to 50,000 cps. Simultaneous observation and recording of four strains are possible.

Nonhardening Straight Chromium Stainless Steel

The current restrictions on the use of nickel in steel have forced engineers associated with the design, fabrication, and application of equipment using vital chrome-nickel stainless steels to seriously investigate the use of straight chromium stainless grades. To assist in solving the problem, The Babcock & Wilcox Tube Co., has published a new four-page bulletin outlining the physical and mechanical characteristics of three non-hardening straight chromium stainless tubing steels. Known as Bulletin TDC 140, it discusses B & W Croloy 18 Al (AISI Type 405), B & W Croloy 19 (AISI Type 430) and B & W Croloy 27 (AISI Type 446). Included are technical data on analyses, creep strength, properties at room and elevated temperatures, corrosion and oxidation resistance, forging, forming, machining, welding, and heat-treatment. Copies of Bulletin TDC 140 are available free on request to the company's offices at Beaver Falls, Pa.

Precipitron

An eight-page leaflet that describes the precipitron electronic air cleaner in non-technical language is available from Westinghouse Electric Corp. Air cleaning units for factories, for stores, for offices, and for homes are covered.

The leaflet describes the precipitron and explains how it operates; why it cleans air so efficiently; where it can be used to advantage; how it is constructed; and, the kind of unit to select for a given job of air cleaning.

For a copy of leaflet SA-6691 that describes the precipitron write Westinghouse Electric Corp., Sturtevant Div., 200 Readville St., Hyde Park, Boston 36, Mass.

Vacuum-Coating Unit Chart

A new data sheet now being offered by Distillation Products Industries, a division of Eastman Kodak Co., describes in detail the construction, capabilities, and performance of all vacuum coating units produced by D.P.I. Equipment of this type. Originally used in the optical field alone, the equipment is now being employed with even greater frequency for such uses as shadowing electron microscope specimens, manufacturing telephone capacitors, and reclaiming waste plastic by filming molded toys with shiny metal.

This chart enables quick comparison of units as to utilities, and approximate shipping weight. Each of these general headings is then subdivided to provide detailed information on particular characteristics.

Data sheets now available in addition to that describing the vacuum coating units include the D.P.I. Ionization Gauge Control Circuit, Type DPA-38; the Ionization Gauge Tube, Type VG-1a; the Thermocouple Gauge, Type TG-02; and the Philips Gauge, Type PHG-1.

Copies of the sheets may be obtained on request to Vacuum Equipment Div., Distillation Products Industries, Rochester 3, N. Y.

• Keep Informed

Temperature Compensated Strain Gages

A new 2-page Bulletin, No. 174, describes, shows graphic performance and gives specifications for ten new type SR-4 resistance wire strain gages. These gages are only slightly affected by temperature variations within certain ranges when bonded to steel or aluminum. Copies may be obtained from Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

Oil and Water Cooler

A new design of oil and water cooler with several advantageous features is described in a bulletin recently published by the Griscom-Russell Co. The unit, known as the LK-Fin Cooler, is distinguished by the use of helically finned heat-transfer elements instead of conventional bare tubes. The bulletin explains how the LK-Fin elements provide a lighter, more compact and less costly unit for a given cooling service, and diagrams show comparisons of length and number of tubes and size of units for equivalent heat-transfer surface.

The bulletin also describes and illustrates the design details which provide most effective heat transfer, permit free expansion of the tube bundle, prevent interleakage and leakage to the outside, and promote convenience of inspection and cleaning.

Copies of Bulletin 1020 can be obtained from the Griscom-Russell Co., 285 Madison Ave., New York 17, N. Y.

Inclined Draft Gages and Vertical Tube Gages

Of interest to heating, ventilating, and air conditioning men is Bulletin 109 just released by Ellison Draft Gage Co., 214 W. Kinzie St., Chicago 10, Ill. This bulletin describes portable, stationary, and laboratory type inclined draft gages and accessories. Instructions for securing readings in conjunction with Ellison Pilot Tubes are given, as well as suggestions for use of the draft gage in connection with domestic heating plants. Tables and useful data gathered over the years are likewise presented. Copies of the bulletin are available on request.

Industrial Air Conditioning

A 20-page Planning Guide for Industrial Air Conditioning containing technical information reduced to understandable down-to-earth terms has been issued by Westinghouse Electric Corp.

The following five vital functions an air-conditioning system should perform are covered: control temperature, control humidity, clean air, circulate air, and blend outside air with recirculated air. The six components needed to do this job; circulating fan, air cleaner, heating or cooling coil, compressor, condenser, and humidifier, are discussed.

What to expect from an air conditioning system; factors to consider when actually planning a system; where and when to use a "within-the-space" conditioner, a factory assembled central plant type unit, or a field assembled system are also covered.

Illustrations of each kind of equipment are included along with photographs of interiors where these are installed.

For a copy of "A Planning Guide for Industrial Air Conditioning" (Booklet B-5160) write the Westinghouse Electric Corp., Sturtevant Div., 200 Readville St., Hyde Park, Boston 36, Mass.

Continued on Page 62

Manufactured by American Electrical Heater Co. Detroit 2, Michigan

This American Beauty temperature regulating stand brings outstanding economies to soldering operations. The thermostat, actuated by Chace Thermostatic Bimetal, automatically maintains a soldering iron at economical lower temperature between operations, brings it up to full working temperature when removed from the cradle.

Any desired "at rest" temperature, from very low through high, is pre-set at the bottom of the stand. When a hot soldering iron is placed on the metal cradle its heat is conducted to the bimetal actuating element. This causes the bimetal strip, carrying one contact, to rise. A spring, carrying the other contact, also rises, thus maintaining a closed circuit until its end hits a stop at the top of the thermostat. Since the bimetal strip is free to continue its motion while the spring is stopped, the contacts are separated, breaking the circuit. Current to the heating element in the soldering iron is thus cut off until the iron drops to the pre-set temperature. Then the cooling bimetal reverses its deflection, bringing the contacts together to close the circuit to the iron's heating element. When the iron is in use this circuit *remains* closed, since its heat does not reach the thermostat.

This automatic control means labor savings, better soldering, current saving, elimination of fire hazard, longer life for soldering irons and operator comfort and safety. Perhaps *your* product can offer increased benefits through precision control of its performance by Chace Thermostatic Bimetal. Ask the Chace Application Engineer for his suggestions.

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BEST CHOICE

When you have an insulated piping problem, remember that only the best will give you ALL the advantages necessary to full-efficiency performance of your system. That means Ric-wiL Prefabricated Insulated Piping.

Ric-wiL provides (1) top-efficiency system engineering, (2) fast, economical installation, (3) the right protection and insulation for the job.

THE RIC-WIL COMPANY
CLEVELAND, OHIO

Ric·wiL PREFABRICATED INSULATED PIPING
UNDERGROUND OR OVERHEAD

• Keep Informed

Crushers and Pulverizers

A new bulletin issued by American Pulverizer Co., describes special features, speed, capacity, weight, and dimensions of American crushers designed for the reduction of metal turnings, stone, wood, plastics, etc. Illustrates special construction elements, including the roller ring crushing principle, of which American is the originator. Available from American Pulverizer Co., 1541 Macklind Ave., St. Louis 10, Mo.

Gas-Engine-Driven Compressors

A new HBA catalog covering the complete line of Clark Bros. Co., Inc., Olean, N. Y., high-compression Big-Angle compressors has been issued recently.

Covered are Clark Model HBA 5, 6, 8, and 10-cyl compressors ranging from 1100 to 2200 hp. Write for Bulletin 104.

Piping Engineer's Dimensional Data Card

Dimensions on welding fittings and flanges that could otherwise be found only by searching through many catalog pages and tables have been condensed and reproduced by Taylor Forge & Pipe Works on two sides of an $8\frac{1}{2} \times 11$-in. card.

One side covers the broad WeldELL line of Taylor Forge welding fittings. It shows the wall thickness and the essential dimensions for all types of fittings for very nominal pipe size from $\frac{1}{2}$ in. through 30 in. The other side covers the world's most complete line of forged-steel flanges. The essential dimensions and bolting data are given for all types of flanges, in all weights, for nominal pipe sizes from $\frac{1}{2}$ in. through 24 in.

Cards are available, upon request, to anyone concerned with piping problems or applications, from Taylor Forge & Pipe Works, P. O. Box 485, Chicago 90, Ill.

Conserving Strategic Materials

American Cladmetals Co., Carnegie, Pa., has issued a new booklet entitled "Conserving Strategic Materials." Aimed primarily at the aircraft industry, it nevertheless offers some vivid comparisons of how as much as 30 per cent vital alloys may be saved in other industries, too.

This new Rosslyn Metal booklet graphically compares foreign sources and United States domestic supplies of nickel, cobalt, columbium, copper, chromium, and tungsten. Also, it points out how to achieve simultaneous savings of these metals and better product performance by use of high-temperature alloy metals in the Cladmetal form.

Several types of Cladmetal sheets are depicted in colored graphs to show how strategic high alloys are saved and product performance improved at the same time. The booklet is available free of charge. Write to American Cladmetals Co., Carnegie, Pa.

Inductrol Power Packs

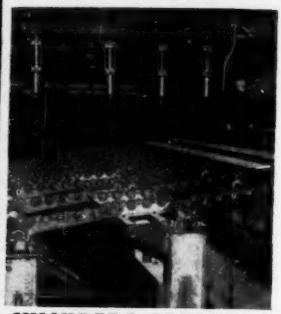
A new "midget" load center unit substation specially designed for low-voltage, regulated a-c lighting and power service in factories and laboratories is described by the General Electric Company's Unit Equipment Division, in Bulletin GEA-5571.

Called an Inductrol Power Pack, the unit incorporates in one steel housing an air circuit breaker, a dry-type transformer, and an air-cooled induction regulator.

The new pack, available in either single or three-phase ratings, has a capacity ranging from 15 to 100-kva, with incoming circuit rated 480 or 600 volts, 60 cycles, and a regulated output at 120/240 or 208Y/120 volts.

Ledeen cylinders
improve the job

Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders •



CYLINDERS OPERATE BRIDGING SECTIONS OF LUMBER SEPARATOR

Illustration shows lumber separator and grading table behind #2 resaw at Booth-Kelly Lumber Company, Springfield, Oregon. Here the graded boards are separated into 5 segregations depending on subsequent processing required for each board. Bridging sections of the separators are actuated by 4 Ledeen Air-Operated Heavy Duty Cylinders, shown suspended from cross beam at far end of separator.

Standard Ledeen cylinders and mounting attachments are available from distributors' stock in major cities. Special cylinders on order.

Write for New Bulletin 500.

There are Ledeen Medium Duty, Heavy Duty and Super Duty cylinders for air, oil or water operation ready to help you, wherever you have to push or pull • lift or lower • press or squeeze • tilt or turn • open or close

Ledeen Mfg. Co.
1600 San Pedro
Los Angeles 15, Calif.

• Keep Informed

Zeolite Softener

Cochrane Corp., Philadelphia, Pa., has issued a new Bulletin No. 4520, on sodium zeolite water softeners. This publication gives a detailed explanation of the sodium zeolite softening process containing a definition of terms employed in this description, the data necessary for laying out a zeolite water softening plant, the factors governing the sizing of such equipment, the selection of zeolite material and a description of both siliceous zeolites and nonsiliceous zeolites and a description of the four steps of operation of a zeolite softener.

Included is a complete description of the unique single control valve, known as the hydromatic valve, characteristic of all Cochrane zeolite equipment with a detailed description of the details of construction of the entire zeolite softener equipment including accessories, regenerating equipment, etc.

Cavitation Research

A new 20-page bulletin, "Accelerated Cavitation Research," which describes cavitation-pitting tests has been released by Allis-Chalmers Mfg. Co. The tests described were conducted to solve some of the phenomena of cavitation and to determine the relative resistance to pitting of recently developed materials and techniques for applying these materials.

Contents of the bulletin are based upon a paper presented at the Annual Meeting of the ASME on Nov. 29, 1949, by William J. Rheingans, assistant manager of Allis-Chalmers hydraulic department. The paper was subsequently published in the July, 1950, Trans. ASME.

Copies of "Accelerated Cavitation Research," O2B7581, are available upon request from Allis-Chalmers Mfg. Co., 949 S. 70 St., Milwaukee, Wis.

Shear Seal Valves

Barksdale Valves., 1566 E. Slauson Ave., Los Angeles 11, Calif., has issued a new catalog on Barksdale Manual "Shear-Seal" Valves. It covers the entire range of shut-off, selector, and manipulator valves for pressures from 0 to 6000 psi. It contains explanatory copy and illustrations of the patented "Shear-Seal" principle: A pressure balanced, self aligning, tubular valve seat maintains intimate contact with an optically flat porting disc. Flow passages are opened or closed by the rotary movement of this disc. Fluid flow is always through the center of the "Shear-Seal," never across sealing surfaces.

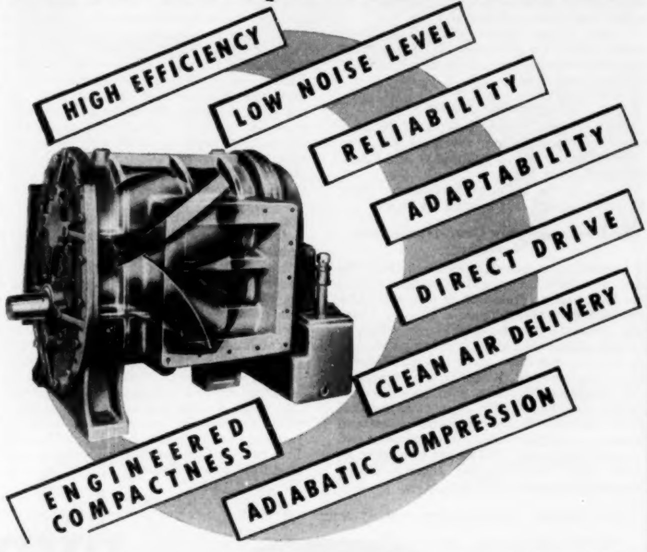
Included in the catalog is a simple outline for determining proper valve size with tables giving steel pipe data and capacities of hydraulic rams.

Improved Spreader Stoker

Improved type of Spreader Stoker—Bulletin No. 50 describes this improved type of spreader stoker, having a forward moving grate that slowly and continuously discharges the ash at the front. Fuel is fed to the furnace by overthrow rotors that provides exceptionally uniform fuel distribution. High burning rates permit increased capacities per foot of furnace width, keeping down investments in both steam-generating equipment and building. All grades of bituminous coal or lignite as well as wood and other types of refuse are successfully burned. Thermal efficiency is exceptionally high—either with steady or fluctuating loads. Detroit Stoker Co., Detroit, Mich.

Continued on Page 64

The STANDARDAIRE BLOWER offers these exceptional features



WHETHER you require 20 cfm or 15,000 cfm capacity blowers these features are inherent in the unique design of the modern Standardaire positive displacement blower. Its epicycloidal rotor form acting as an air screw is unlike that used in the conventional lobe type unit—and Standardaire blowers have demonstrated their all-around superior performance to the satisfaction of many leading industrial users.

Send today for complete information. If you have specific requirements our engineers will welcome the opportunity to work with you. Write Dept. E15 The Standard Stoker Company, Inc., 370 Lexington Avenue, New York 17, N. Y.

Do you have the 1951 STANDARDAIRE Selection Chart?

THE STANDARD STOKER CO., INC.

Standard Stoker

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• Keep Informed . . .

Regulators

A 32-page booklet containing useful information about pilot-operated pressure and temperature regulators is available from Spence Engineering Co., Inc., Walden, N. Y. Illustrated with photos, charts, and tables, the booklet discusses main valves, controls and strainers, gives capacity and flow data as well as dimensions and weights.

A new 4-page folder is available from Spence which also gives useful information on temperature regulators, pressure regulators, and desuperheaters.

Expansion Joints

The 16-page Yarway Bulletin EJ-1912 on expansion joints has been reprinted and gives information on Yarway Gunpakt and Glanpakt Expansion Joints.

Copies of the bulletin are available from Yarnall-Waring Co., Philadelphia 18, Pa.

Radio-Frequency Gear-Hardening Machine

Detailed operational information about the new radio-frequency gear-hardening machine, the Inductall, is presented in a new booklet available from Westinghouse Electric Corp. The Inductall's adaptability in handling spindle gears, spur gears, cluster gears, and shafts for either through or contour hardening is explained with the help of diagrams and photographs. The new booklet illustrates the Inductall's simple mechanical drive system. It also diagrams power and water requirements for an installation of two or more machines. For a copy of booklet B-5259, write Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

Welding End Specifications Table

The latest issue of "Valve Values," a sales and service publication of Edward Valves, Inc., East Chicago, Ind., includes a table of welding end specifications for Edward cast-steel valves which is of value to valve specification writers, valve buyers, and piping fabricators. This reference table, developed from specifications of the American Steel flange standard B16e of 1939, the ASA B31.1–1951 Code for Pressure Piping, the ASME Power Boiler Code for 1946, and Pipe Fabrication Institute Standard ES1–1948, is especially designed for removal from the company magazine for handy desk top reference. It contains, in addition to Edward standard dimensions of welding ends, diagrams of straight bevels for pipe wall thicknesses of $^3/_4$ in. and less, and diagrams of U-bevels for pipe wall thicknesses of over $^3/_4$ in.

Insulating Fire Brick

A new 4-page illustrated folder has been published by Johns-Manville recently. Entitled, "JM-3000 Insulating Fire Brick," it presents the economic advantages, industrial applications, and refractory properties of this product, the first insulating fire brick for sustained use at 3000 F. Physical and thermal characteristics are given in table form. An illustrated description highlights the use of these insulating fire brick in the construction of a slot-type forging furnace. The folder also contains summarized information on accessory materials and other insulating brick made by Johns-Manville. Free copies of this publication are now available from Johns-Manville, 22 East 40th St., New York 16, N. Y.

Flexible Couplings

A new, 4-page, illustrated Folder No. 2363 on Link-Belt "RC" Roller Chain Flexible Shaft Couplings has been published by Link-Belt Co. Engineering information for proper application includes dimensions, weights, service factors, and horsepower ratings. Detailed data are also given on two types of protective grease-retaining casings—Style R (spun metal revolving type) and Style P (Plastic, revolving type). A copy of new Folder No. 2363 will be sent upon request, to Link-Belt Co. 307 N. Michigan Ave., Chicago 1, Ill.

Heat Transfer Equipment

Patterson-Kelley Company, Inc., 85 Warren St., East Stroudsburg, Pa., manufacturers of heat-transfer and process equipment, have issued a new 4-page condensed catalog showing representative items in their line of heat-transfer equipment, blenders, and process vessels such as kettles, mixers, autoclaves, etc. Essentially this is an illustrated index of P-K equipment. Complete catalog details are available for all of the items listed. Copies of Catalog No. 10 will be sent on request.

Copying Machines

Charles Bruning Co., Inc., 100 Reade St., New York 13, N. Y., announces publication of a new 8-page Booklet A-1081 describing how the BW Copyflex and other Bruning copying machines can both simplify and speed up paper work in all departments of business and industry. Copies available on request to the company.

• Keep Informed

Materials Handling Equipment

In the latest issue of "Material Handling News," Clark Equipment Co., makes a report to industry on its new and better mechanized materials handling.

Among subjects covered are the Dynatork drive, a Clark development which transmits engine power to the drive-axle by magnetic induction, across an air gap, and eliminates the conventional clutch; an improved line of electric battery-powered fork-lift trucks, incorporating many exclusive features; the newly developed Clark powered hand-pallet trucks with their exclusive motor mounted in the wheel—the Electro-Lift, with battery power, and the Hydro-Lift, gas-powered and driven by a hydraulic motor; its new Model-B Clamp; the new Pul-Pac, which eliminates use of conventional pallets and handles loads on a low-cost paper carrier sheet; and a number of new attachments for special handling needs of various industries.

A copy of the report will be mailed at no charge in response to request made on regular business letterheads to the Clark Equipment Co., Industrial Truck Div., Battle Creek, Mich.

High-Speed Motion Picture Cameras

A new catalog issued by Wollensak Optical Co., Industrial and Technical Div., contains information, specifications, and applications of the 8, 16, and 35-mm Fastax high-speed motion picture cameras and 16-mm oscilloscope camera. The bulletin tells how to set up a high speed photographic laboratory and gives complete information on new optics (delivering high resolution) on all Fastax cameras. These cameras make motion studies of mechanical, electrical, physical, and anatomical reflexes and vibrations and permit the taking of pictures up to 14,000 frames per sec.

Stainless Tubing Steels

Technical data valuable to engineers associated with the design, fabrication, and application of stainless tubing is offered in a new four-page Bulletin No. 19 published by The Babcock & Wilcox Tube Co. It contains condensed data on analyses, oxidation resistance, thermal treatment, and mechanical, electrical, and physical properties on ten of the most popular austenitic and ferritic stainless tubing steels. Copies of this bulletin are available free on request to the Company's offices at Beaver Falls, Pa.

Spray Nozzles

Recooling spray nozzle systems for use in plants which operate condensers or use large quantities of water for cooling, are pictured and described in a new Bulletin 6A-SP, recently issued by Schutte & Koerting Co.

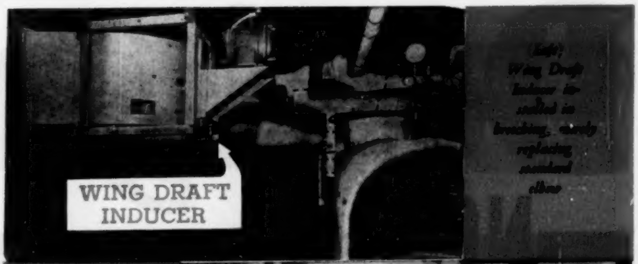
The eight-page bulletin details design, application, construction, and operation of SK spray nozzles, and diagrams typical spray pond arrangements. Sizes, dimensions, capacities, and spray nozzle patterns are included in tabular form for each nozzle size.

A temperature graph gives cooling performance curves for SK spray nozzles for various temperature ranges using 7 psi at the nozzle.

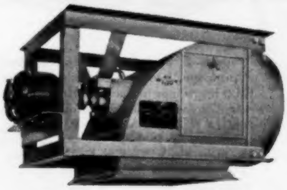
Atmospheric conditions and operating pressures are discussed in the text material.

The bulletin also diagrams and describes SK Louvre Screens which are designed to prevent spray from being carried away by wind while, at the same time, providing for maximum air passage for cooling.

For copies of this bulletin, write to Dept. J-D, Schutte & Koerting Co., Cornwells Heights, Bucks County, Pa.



How to Insure Positive Draft



Write for a copy of Bulletin on Wing Draft Inducers

The Wing Draft Inducer provides a means for furnishing positive, uniform, adequate draft for low pressure heating plants without the need for tall, unsightly, expensive stacks.

It permits operating at high efficiencies without regard to weather conditions.

Thorough and efficient combustion with high CO_2 content is assured. Smoke, gas and explosion hazards are reduced or eliminated.

L. J. Wing Mfg. Co. 156 Vreeland Mills Road, Linden, N. J.
Factories: Linden, N. J. and Montreal, Canada

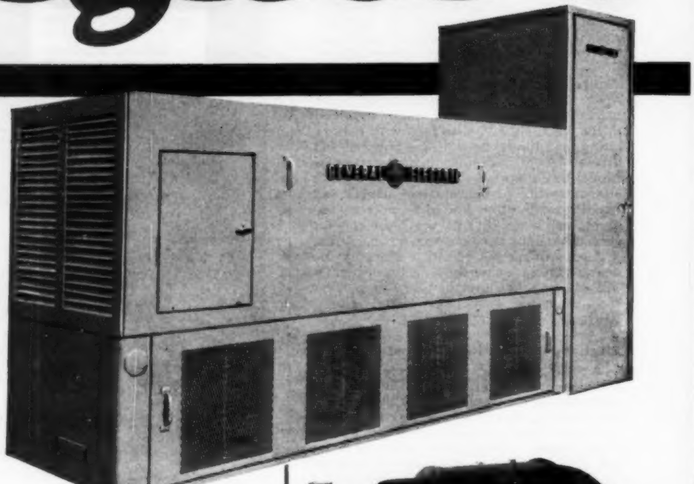
WING

Wing DRAFT INDUCERS

Designer's

NOW

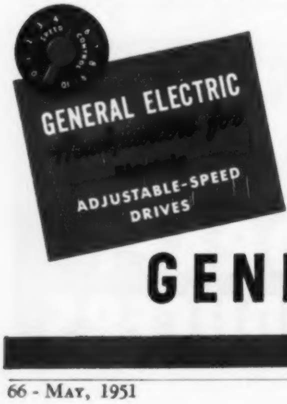
up to 200 hp in one compact package!



New G-E Speed Variator power "package," typical of ratings 75 to 200 hp, comes in two units for greater plant-layout flexibility. M-g set cabinet (5 ft ⅛ in. high by 9 ft 9½ in. wide by 3 ft 4 in. deep) may be located away from or bolted to control cabinet (7 ft 6 in. high by 2 ft 6 in. wide by 3 ft 4 in. deep).

SPEED VARIATORS

All the advantages designers have appreciated in General Electric Speed Variators—packaged, pre-engineered adjustable-speed drives operating from a-c power systems—can now be obtained in units rated 75 to 200 hp. On punch presses, wire drawing machines, mill auxiliary drives, etc., they provide the same speed ranges up to 40:1 and beyond, good speed regulation, great operating flexibility, and minimum installation and maintenance cost.



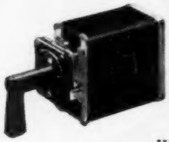
With adjustable-voltage control in whatever type is most suited to the need—straight magnetic, amplidyne, or electronic—this new drive requires no special foundations, includes all necessary protective features, and contains all wiring between components except to the remotely-mounted motor and operator's controls.

Best of all, standardized component design lets you specify only the features you need, permits prices comparable to other drives that require costly field assembly. For more information on these new larger-hp Speed Variators, check your nearest G-E Apparatus Sales Office. Bulletin GEA-5335 describes Speed Variators in 1–60 hp ratings.

GENERAL ELECTRIC

Digest

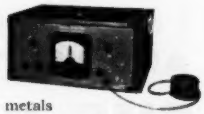
PRODUCT HIGHLIGHTS



VERSATILE SWITCH makes good 10,000 ways!

What's behind the success story of the General Electric Type SB-1 switch? Simply this: By varying its many ***standard, interchangeable*** cams, contacts, fingers and other parts, you can arrange for over 10,000 control and transfer combinations, use it for practically any control job on low-capacity circuits. For extra-heavy duty, there's the tougher Type SB-9, with the same features plus extra wear-resistance. Both types mount on ⅛- to 2-inch-thick panels, are rated up to 20 amperes at 600 volts a-c or d-c. See Bulletins GEA-4746 (SB-1) and GEA-4114 (SB-9).

METALS COMPARATOR cuts scrap losses economically!



With both ferrous and non-ferrous metals now in tight supply, you'll need the material savings a General Electric metals comparator can bring you. It provides an economical, non-destructive test of metal parts for composition, heat treatment, hardness, or plating thickness—decreases scrap losses due to mixed material or incorrect processing. Parts are quickly compared against a reference standard. Uses single-phase, 60-cycle, 110-volt supply. See Bulletin GEC-566.

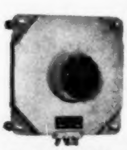
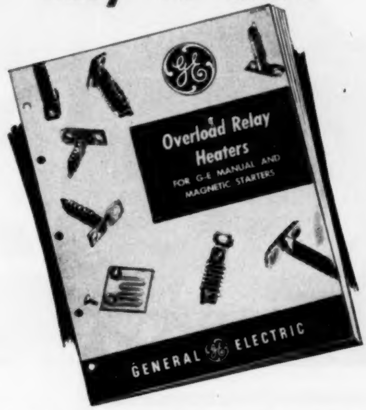


PLATE-TYPE RHEOSTAT gives accurate speed control!

Specify these General Electric plate-type field rheostats for mounting on a machine tool, switchboard, or control or operator's panel, and you've provided for speed control of d-c motors, or voltage control of generators and exciters. The 6-, 9-, and 12-inch standard sizes contain 27, 52, and 70 resistance steps for accurate adjustment. Adjustable stops at each end of travel save time, assure uniform operation, are easily reset for added flexibility. See Bulletin GEC-487.

New! Complete! Easy to use!



LISTS RELAY-HEATER RATINGS FOR G-E MOTOR STARTERS

Just out is this handy guide to the selection of overload relay heaters for most types and sizes of General Electric manual and magnetic starters. In one convenient 16-page reference booklet, it concentrates data from many sources, makes it easier and faster for you to match heaters to motors. Check Bulletin GEC-127B in the coupon below.

General Electric Company, Sec. L668-88
Schenectady 5, New York

Please send me the following bulletins:

√ for reference purposes
X in connection with immediate projects

- ☐ GEA-4114 Type SB-9 switch
- ☐ GEA-4746 Type SB-1 switch
- ☐ GEA-5335 1-60 hp speed variator
- ☐ GEC-127 Relay-heater catalog
- ☐ GEC-487 Plate-type field rheostat
- ☐ GEC-566 Metals comparator

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

Name ....

Company ....

Street ....

City .... State ....

Typical thermometer and barometer desk set made by Standard Thermometer, Inc., 952 Dorchester Ave., Boston 25, Mass. Standard's instruments are not only sold to government, industry and over the counter, but many are also imprinted with company names and become valued gifts to top executives of important customers.

Punching spoke holes in brass cups which have been drawn, cut, and passed by Inspection.

TO MEASURE TIME AND WEATHER

BEGIN WITH THE BRASS

● Standard Thermometer, Inc., is a well-known maker of thermometers, barometers, hygrometers, and clocks, for outdoor, desk, and industrial use. Naturally, brass is an important item in these instruments, being used for cases because of its golden beauty and for operating parts because of its reliable physical characteristics, including corrosion resistance.

Fabrication methods include stamping and drawing of cases and bezels. The company is an old and experienced one, dating back to 1885, and has been a Revere customer since that time. Recently it began to experience certain fabrication difficulties. When Revere heard about them, the Technical Advisory Service was asked to look into the matter. The brass being used was analyzed, and factory tools and methods studied. An elaborate 17-page report was prepared, including photographs of micro-sections to show the grain structure of various samples, and detailed recommendations were made. In general, it was found that such things as puckers, orange peel, and flare were due to a combination of factors, including composition of the brass, its temper, the dies, and the lubricant used on them. Standards were set up for metal specification and though Revere does not design dies, suggestions were made for the consideration of the designers.

After digesting the report and putting the recommendations to the proof, Standard wrote: "We are extremely grateful for this information, and it represents a splendid job and one of great value to us."

Perhaps Revere can work with you too on such matters as specification, fabrication, ideas to save precious metal. Our collaboration is freely given.

REVERE 150th YEAR OF SERVICE TO AMERICA

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. — Sales Offices in Principal Cities, Distributors Everywhere

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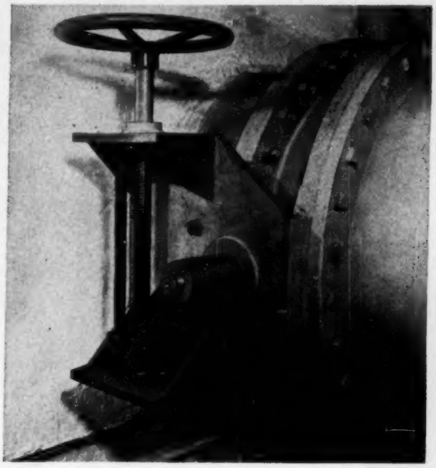
R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



RUGGED Simplicity

Correctly engineered mechanically and metallurgically, all body assemblies of R-S Valves equal or exceed A. S. A. standards in every detail. These valves are designed and constructed for rugged service and provided with such safety factors that they will exceed service expectations as well as reduce pumping and blower costs.

Consider also the few working parts, greater control rangeability, the self-cleaning feature and the fact that R-S Valves are readily adapted to automatic operation. Know the rugged simplicity of R-S Valves, and get the most from your valve investment.

District offices are listed in telephone directories as, "R-S Products Corp'n Valves".

R-S PRODUCTS CORPORATION

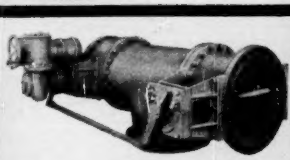
4600 Germantown Avenue, Philadelphia 44, Pa.

An S. Morgan Smith Company Subsidiary

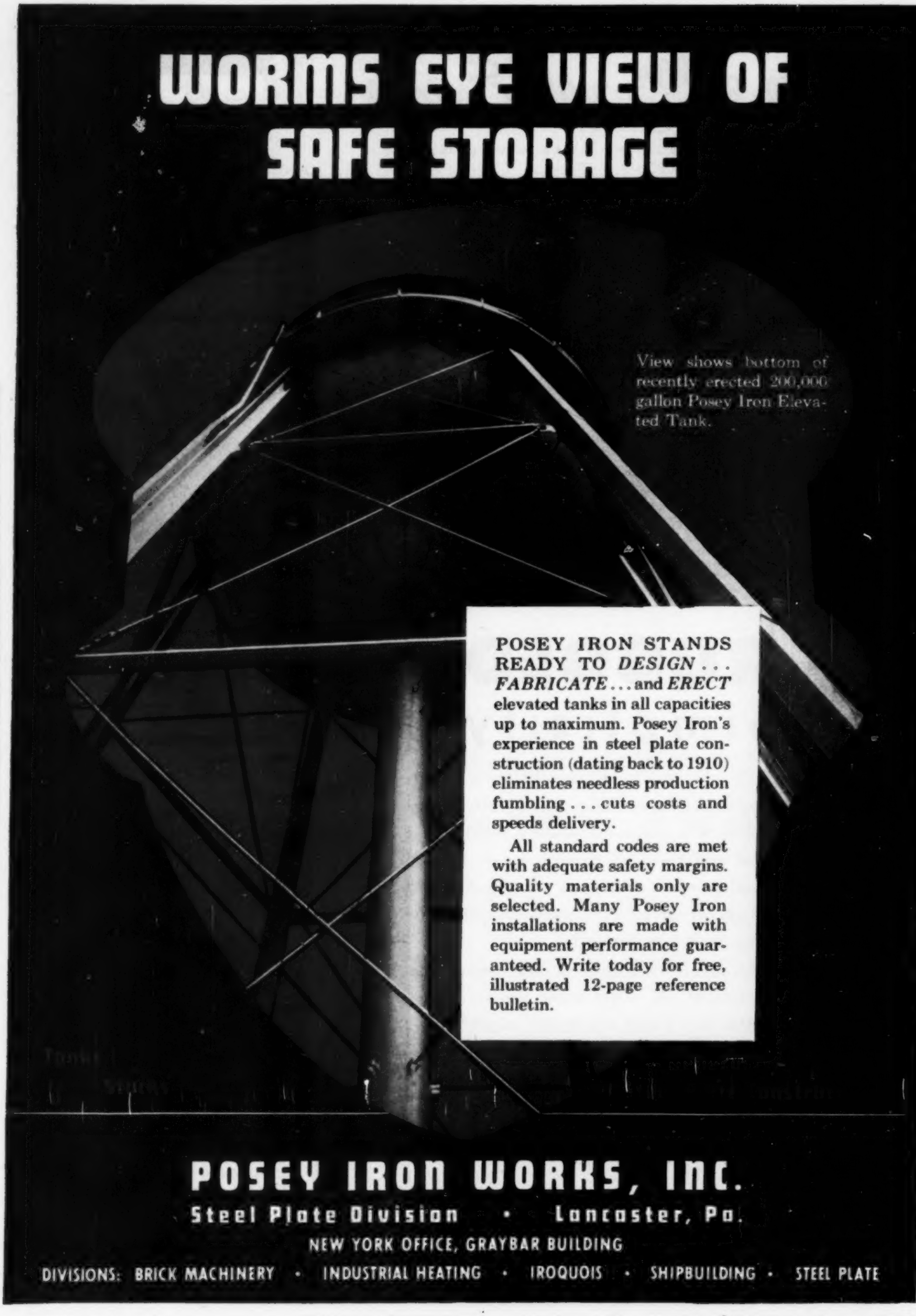
No. 782—Heavy Duty Rubber Seated Wafer Type Valve with 5° angle seated vane and enclosed gear reduction drive. Gland can be removed and stuffing box repacked without removing prime mover.

No. 739-740—Sixty-inch, 50-pound Heavy Duty Valve with gear reduction drive and handwheel for handling water at 40 psig. Vertical valve stem enclosed in steel pipe support. Thrust bearing absorbs vertical load.

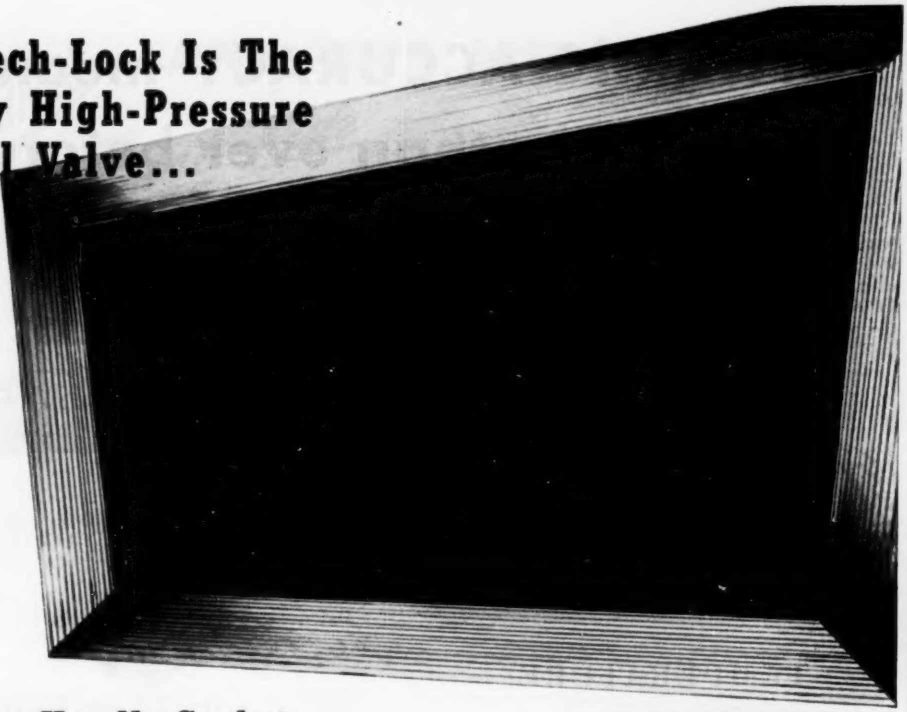
No. 730—R-S Heavy Duty Floor Stand for rugged service in connection with any standard R-S handwheel operated valve.



No. 767—A 3-Way Valve (Two 24-inch 125-pound Cast Iron Valves bolted to 125-pound American Standard Tee). Electric motor operated by cross linkage. Automatic declutching handwheel for emergency operation.


WORMS EYE VIEW OF SAFE STORAGE
View shows bottom of recently erected 200,000 gallon Posey Iron Elevated Tank.
POSEY IRON STANDS READY TO DESIGN . . . FABRICATE . . . and ERECT elevated tanks in all capacities up to maximum. Posey Iron's experience in steel plate construction (dating back to 1910) eliminates needless production fumbling . . . cuts costs and speeds delivery.
All standard codes are met with adequate safety margins. Quality materials only are selected. Many Posey Iron installations are made with equipment performance guaranteed. Write today for free, illustrated 12-page reference bulletin.
POSEY IRON WORKS, INC.
Steel Plate Division • Lancaster, Pa.
NEW YORK OFFICE, GRAYBAR BUILDING
DIVISIONS: BRICK MACHINERY • INDUSTRIAL HEATING • IROQUOIS • SHIPBUILDING • STEEL PLATE

Breech-Lock Is The Only High-Pressure Steel Valve...



- ***That Has No Gaskets***
- ***No Bolts***
- ***No Threads***
- ***Yet Can Be Readily Disassembled In The Field***

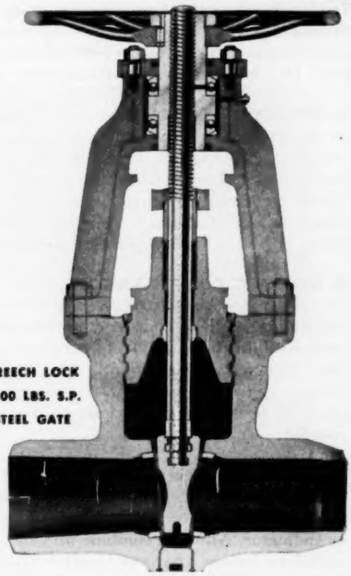
Pressure-tight — without expensive maintenance. Designed to eliminate *all* the common causes of steel valve failure. That's Breech Lock — the exclusive, patented high-pressure valve with the positive *locking* action.

On the Breech Lock Bonnet are four rows of heavy, precisely machined lugs. Matching lugs are in the body. When the bonnet is turned 45°, the lugs intermesh— lock together to carry full internal pressures and distribute stress evenly. A seal weld, which can be readily chipped away with an air-hammer, is applied at the bonnet-joint.

There are no sealing surfaces to corrode, no flanges, gaskets, or bolts to require periodic maintenance. Result — *peak* valve efficiency under the severest conditions.

Write for your copy of "Lunkenheimer Cast Steels," a useful and interesting brochure on the selection of alloys for high-temperature, high-pressure valves. Address: The Lunkenheimer Co., Box 360E, Cincinnati 14, Ohio.

BREECH LOCK
1500 LBS. S.P.
STEEL GATE



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STEEL • IRON • BRONZE

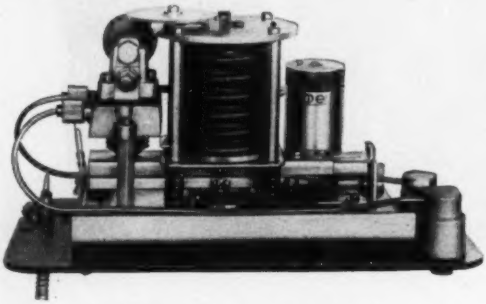
LUNKENHEIMER

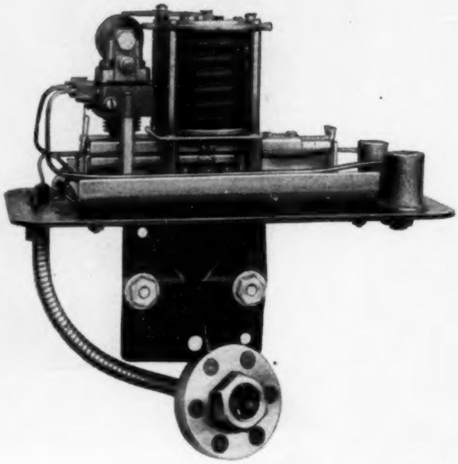
THE ONE *Great* NAME IN VALVES

L-351-12

DYNAMIC ACCURACY means more today than ever before!

Accurate Measurement of changing temperatures and pressures is the vital first step in instrumentation, whether indicating, recording or controlling. Today, TRANSAIRE* Transmitters set new standards for sensitive and accurate measurement.





TEMPERATURE:

Taylor TRANSAIRE Temperature Transmitter with Speed-Act* lets you measure and transmit smallest temperature changes up to 1000 feet with great accuracy! The *only* temperature transmitter that gives you:

1. DYNAMIC ACCURACY—which means the accuracy of an instrument in measuring changing or dynamic conditions. TRANSAIRE Dynamic Accuracy is unparalleled. Solves the problem of process engineers who realize that an instrument accurate to a fraction of a degree in measuring static conditions can be in error by many degrees when temperature is changing.

2. DYNAMIC COMPENSATION—which means ability to compensate for inherent lags both in measuring system and rate of heat transfer of process medium. TRANSAIRE does this by introducing derivative action (Speed-Act) into *measuring* circuit. The result is Dynamic Accuracy, with a speed of response seldom thought possible, permitting much closer automatic temperature control.

TRANSAIRE is the first step in Taylor's TRANSET* Control System. Step No. 2 is the Taylor TRI-ACT* Controller. Step No. 3 is the Taylor TRANSET Recorder or Indicator. All three combine into the already famous complete Taylor TRANSET Control System. **Write for Bulletin 98097.** Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

*Trade-Mark

PRESSURE:

Taylor TRANSAIRE Pressure Transmitter with narrow range spans lets you measure and transmit minute pressure changes up to 1000 feet. Works on simple force-balance principle. Accurate to ½% of the selected short range span (*conventional devices are only accurate up to ½% of upper range limit*). Sensitive to pressure changes of ½" water. Here's accuracy and sensitivity never before thought possible in measuring process pressures—plus the convenience of suppressed ranges at high pressure levels.

THREE IMPORTANT ADVANTAGES:

1. Range spans of 20 and 40 psi available throughout range limits of 35 to 415 psia.

2. Volumetric type pressure system is extremely accurate, practically clog-proof, has corrosion-resistant 316 stainless steel diaphragm.

3. Temperature and barometric compensation for higher accuracy of measurement and control.

Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.

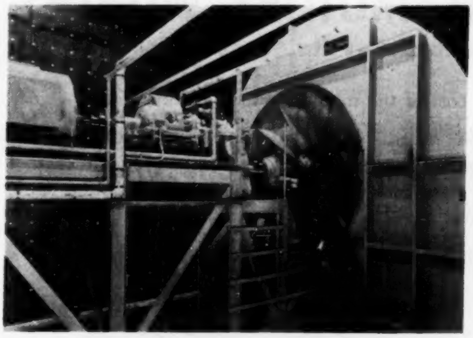
Taylor's Centennial
ACCURACY FIRST SINCE 1851

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

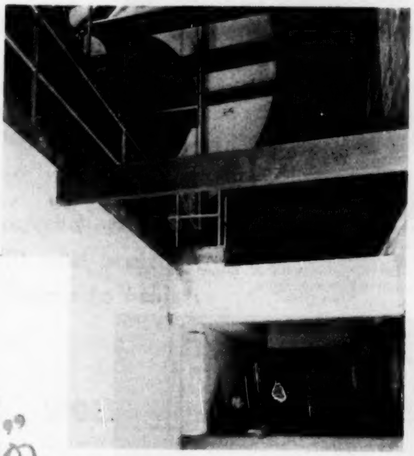
"Buffalo" FANS GIVE AIR A —Fast Ride

. . . as KAUFMANN'S SHOPPERS ENJOY "RESORT" CLIMATE IN ALL 13 STORIES OF PROMINENT PITTSBURGH STORE

- **DELIVERING 15 TONS OF AIR EVERY MINUTE!** The first air conditioning installation utilizing the high duct velocity principle for large interiors. More air thru smaller ducts at faster speeds saves space and money. Designed and installed by The Carrier Corporation, this installation is already highly regarded in the department store field.



- **EXHAUSTING 400,000** cubic feet of air per minute to top of return air shaft, this "Buffalo" LLD Fan completes the air conditioning cycle smoothly, quietly and efficiently. Like Kaufmann's, many of the country's large buildings depend on "Buffalo", First For Fans, for their big air moving jobs.



"Buffalo" CAN SOLVE YOUR AIR PROBLEM!

"Buffalo" builds a complete line of quality fans and air conditioning units to handle your air job . . . and is ready to give you the benefits of its 73 years of experience in air. WRITE FOR FACTS on your problem!

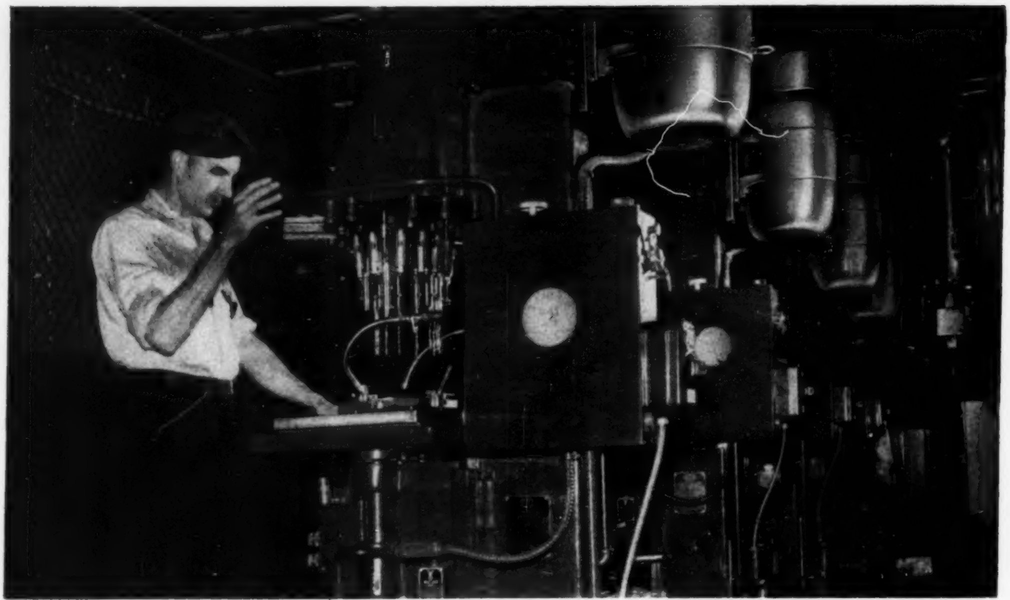
"Buffalo" FIRST FOR FANS

BUFFALO FORGE COMPANY

148 MORTIMER ST. BUFFALO, N. Y.

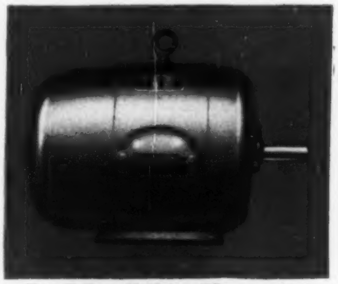
Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Branch offices in all Principal Cities

VENTILATING · FORCED DRAFT · AIR WASHING · COOLING · AIR TEMPERING · HEATING · INDUCED DRAFT · PRESSURE BLOWING · EXHAUSTING

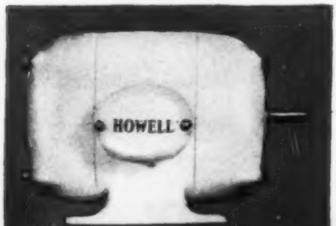


Howell totally enclosed motors power these multiple drill spindles in the plant of a leading auto maker.

HOW MUCH ARE ELECTRIC MOTORS WORTH?



Howell Type K Motor. Offers constant performance in the presence of dirt, dust, fumes and moisture. Sizes from 3 to 150 H.P. at 1800 R.P.M. Either vertical or horizontal mounting.



Howell Sanitary Motors meet the most exacting standards of the dairy and food industries. They contain no pockets, cracks, or crevices. Available for vertical or horizontal mounting.

The actual cost of the motors you see pictured here amounts to hundreds of dollars.

But their true worth, in terms of supplying the power for these multiple drill spindles to turn out finished parts, runs into thousands.

It's tough applications like this which prove the real value of Howell Industrial Type Motors. For your jobs, Howell serves three ways: (1) by engineering electric motors to your job; (2) by furnishing motors of the highest quality; (3) by serving you after the sale.

May we apply our facilities and engineering ability to your problems?

HOWELL ELECTRIC MOTORS COMPANY

Howell, Michigan

HOWELL Red Band MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

Precision-built industrial motors since 1915

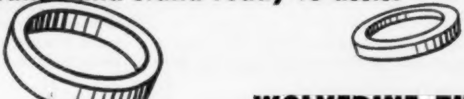
We'll Accept Your Order for COPPER ROTATING BANDS

We are equipped to make sizes up thru 155 MM

These rotating bands—made of Wolverine seamless tube—either all copper or 90-10 gilding metal—are produced under most exacting specifications—they are quality-controlled from ore to finished product.

You are invited to draw on the facilities offered by our Customer Engineering Service for any help you need regarding this type of material—including any assistance you may require in seating blanks.

Wolverine engineers have conducted considerable research in the development and production of rotating bands and stand ready to assist you at all times.

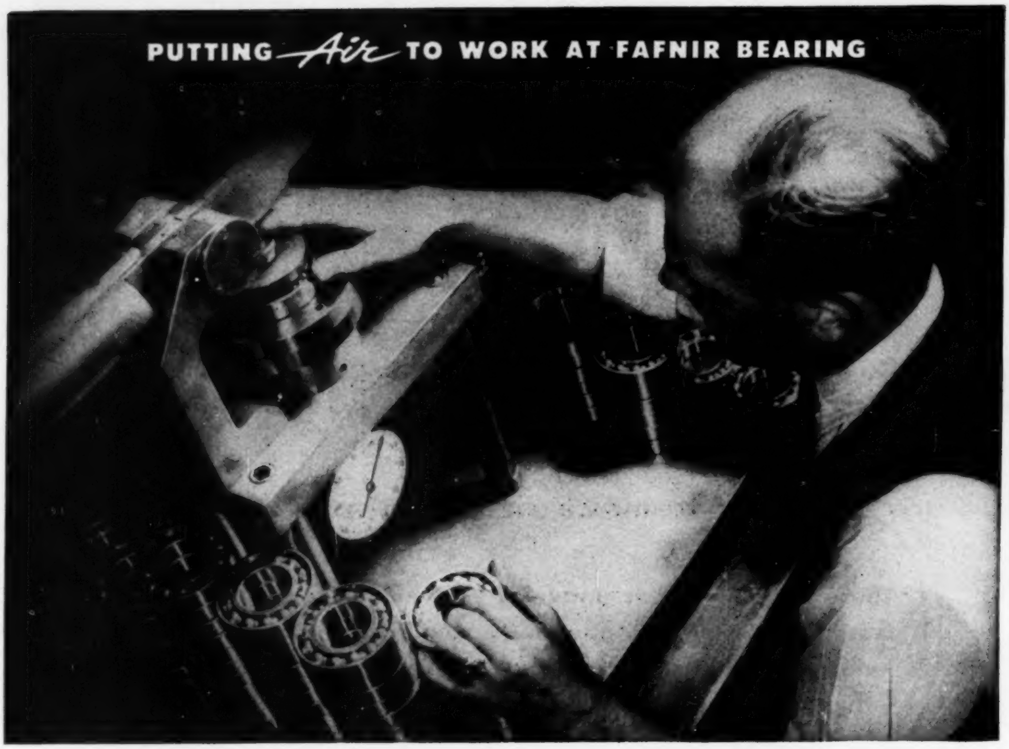


WOLVERINE TUBE DIVISION

Calumet & Hecla Consolidated Copper Company
INCORPORATED
Manufacturers of seamless, non-ferrous tubing
1437 CENTRAL AVENUE • DETROIT 9, MICHIGAN

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
Sales Offices in Principal Cities

Export Department, 13 E. 40th St., New York 16, N. Y.



FINAL EXAM ...

WHERE AIR CAN FLUNK PRODUCTION

Tolerances to ± .0002" at final inspection are tough to gauge in dust-laden, humid air. A microscopic dirt particle can spoil the work of a hundred hands . . . if it interferes with the precision testing of finished ball bearings at The Fafnir Bearing Company. But Westinghouse *put air to work* . . . to solve their problem with an atmosphere control system, and PRECIPITRON®, the highly efficient electronic air cleaner.

Now, thanks to dust-free air and controlled atmosphere, Fafnir has eliminated those minute, production-crippling dirt specks. Mirror-like finishes on balls and races don't rust or corrode from excess moisture.

If your operations call for close tolerances—for precision machining, grinding, finishing or inspecting—there is industry-proven Westinghouse Air Conditioning equipment ready to help you increase production and cut costs. Call the nearest Westinghouse Sturtevant office, or write Westinghouse Electric Corporation, Sturtevant Division, Hyde Park, Boston 36, Massachusetts.

YOU CAN BE SURE...IF IT'S **Westinghouse**

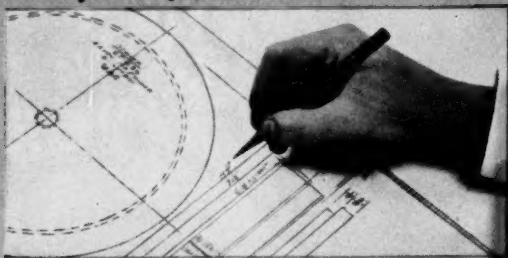
PUTTING Air TO WORK

J-80214

Announcing Kodagraph Autopositive Paper Translucent

a new photographic intermediate material that speeds up print-making . . . drafting

***30% more translucent* than "regular" Autopositive —for faster quantity-print production**



***So translucent* . . . you can easily read details on opposite side**

Here is a new type of Kodagraph Autopositive Paper . . . especially designed to give you increased speed in large-volume print production.

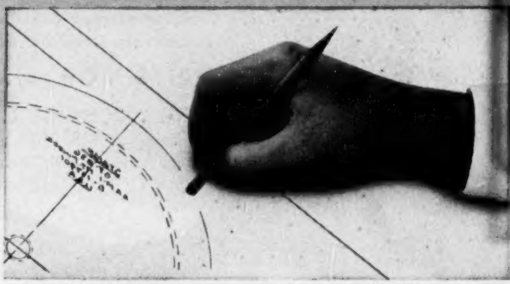
Like "regular" Autopositive, *Kodagraph Autopositive Paper, Translucent* can be handled in room light . . . prints directly to a positive in familiar reproduction equipment . . . is processed in standard photographic solutions. It reproduces original detail sharply, crisply . . . and its dense black photographic lines will not fade, smudge, or wear off.

But this new paper has an important "extra" which you'll spot at first glance—*an entirely new base* . . . remarkably translucent . . . remarkably durable.

Its 30% extra translucency enables you to turn out sparkling blueprints or direct-process prints faster, which lowers production costs considerably in large-volume work. *And it makes practical and convenient* the general use of "reverse-reading" intermediates (which assure final prints of top quality).

Its extra durability simplifies the handling of larger-size sheets . . . offers increased resistance to wear and tear in print-making and drafting.

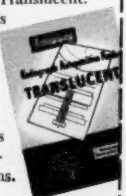
Reverse-reading intermediates, while better for print-making, used to be a problem in the drafting room. But no longer! Now the draftsman simply turns this highly translucent paper over . . . reads through the back—sees every detail sharp and clear. Additions, when necessary, are also made on this side.



Another drafting "PLUS." Unwanted detail can be removed from an Autopositive Translucent print in seconds with an ordinary eraser, without appreciable effect on the base, when the area involved is moistened slightly.

MAIL COUPON TODAY

. . . for full details on Kodagraph Autopositive Paper, Translucent. Intermediates on this new paper (which you or your commercial blueprinter can make) may well prove the key to important savings in your drawing reproduction operations.



EASTMAN KODAK COMPANY, INDUSTRIAL PHOTOGRAPHIC DIVISION
ROCHESTER 4, N. Y. 16

Gentlemen: Please send me a copy of your new free folder describing Kodagraph Autopositive Paper, *Translucent*.

Name________________ Position__________

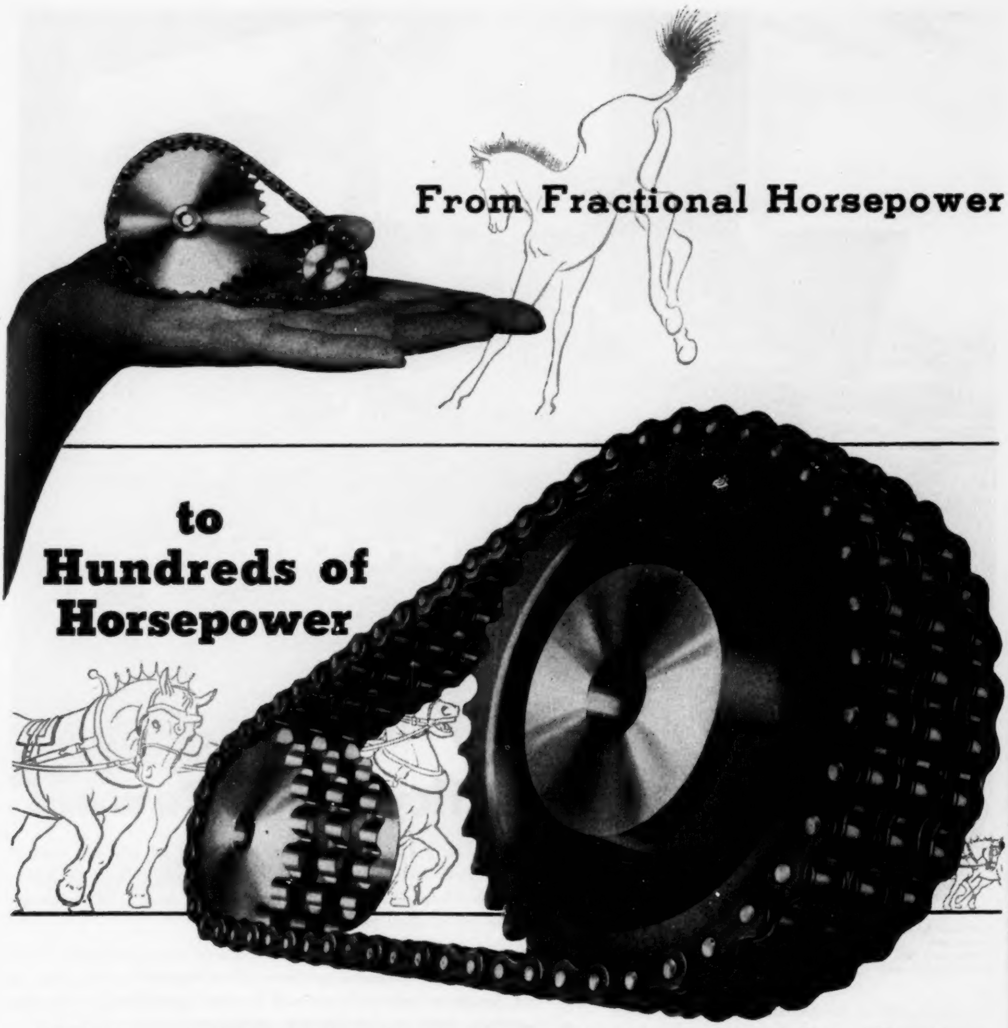
Company________________

Street________________

City__________ ________ State________

Kodak
TRADE-MARK

WHEREVER
It's Hot
SPECIFY
PROTECTIVE COATINGS
Made With
DOW CORNING SILICONES
for maximum weather resistance, excellent gloss and color retention plus stability at 500°F. to 1000°F.
WRITE FOR LIST OF SUPPLIERS
DOW CORNING CORPORATION
MIDLAND, MICHIGAN
SILICONES
ATLANTA • CHICAGO • CLEVELAND • DALLAS • LOS ANGELES • NEW YORK • WASHINGTON, D. C.



Whitney Chain Drives Simplify Design—Cut Costs

No matter what your drive problem, be it small movie cameras, machine tools or earth movers, you will find a Whitney Chain Drive to fill the application exactly.

And what's more, these adaptable drives offer opportunities for important cost reductions and improved performance. *For example*— Whitney Chain Drives operate equally well on long or short centers. They will drive single or multiple shafts, provide accurate timing or reversal of direction. Standard attachments, built into the chain, offer still more opportunities for economical application possibilities.

And remember, Whitney Chains ... *the all-steel drives* ... deliver *full rated* power, smoothly and dependably. Their positive grip transmits constant, uniform speed. They are easily and quickly installed, reducing costly down time. No removal of shafts or bearings necessary. Alloy steel construction assures maximum service with minimum maintenance.

WHITNEY ENGINEERING SERVICE— In addition to the service facilities of more than 130 Distributors, Whitney maintains a network of 15 Field Engineering Offices, located throughout the country. From the complete line of Roller, Silent and Conveyor chains, Whitney engineers can recommend the proper type of drive for your application ... the chain drive which will give you the best service at lowest cost. Consult your nearest Whitney field office or write us direct for catalog and complete information.

WHITNEY CHAIN COMPANY

240 Hamilton Street, Hartford 2, Connecticut

Fabricated by an equipment builder using the Lukenomics principle

. . . or Alkylation Towers

Project records on this alkylation tower tell a typical Lukenomics story . . . excellent performance, lower costs, simplified construction. The problems presented were solved so well by the equipment builder's experience and his use of Lukens specialty steel plate, heads and steel plate shapes that seven similar towers have since been built. Particularly important now—the long life built into the equipment helps conserve strategic materials.

Whatever your project, it's important! Don't let today's restrictions kidnap efficiency. That's where progressive equipment builders can help. Delivering improved production, despite current conditions, is one of their prime contributions.

An important factor in this is their application of the Lukenomics principle. For Lukenomics combines their experience and that of leading designers and engineers with Lukens' specialized knowledge of materials, their production and application.

Get this *extra* attention for your project. We'll gladly put you in touch with equipment builders applying the Lukenomics principle. Just write, stating your problem, to Manager, Marketing Service, Lukens Steel Company, 402 Lukens Building, Coatesville, Pa.

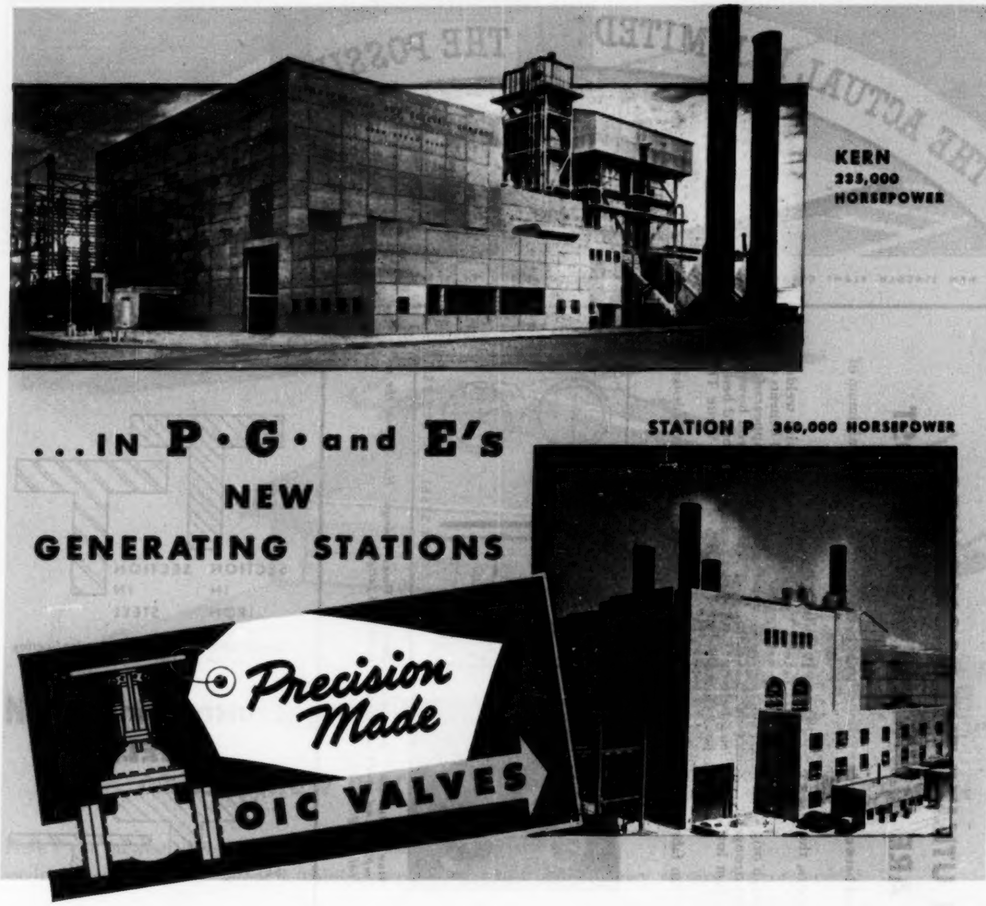
Promote steel production generally—speed sale of your scrap.

LUKENS

LUKENS STEEL COMPANY

OVER 140 YEARS' EXPERIENCE AS THE WORLD'S LEADING PRODUCER OF SPECIALTY STEEL PRODUCTS

STEEL PLATE — CLAD STEELS — HEADS — STEEL PLATE SHAPES



The Ohio Injector Company is proud that OIC Valves are having a share in Pacific Gas & Electric Company's mammoth expansion program to bring more power to Northern and Central California. It is a compliment to the quality of our product.

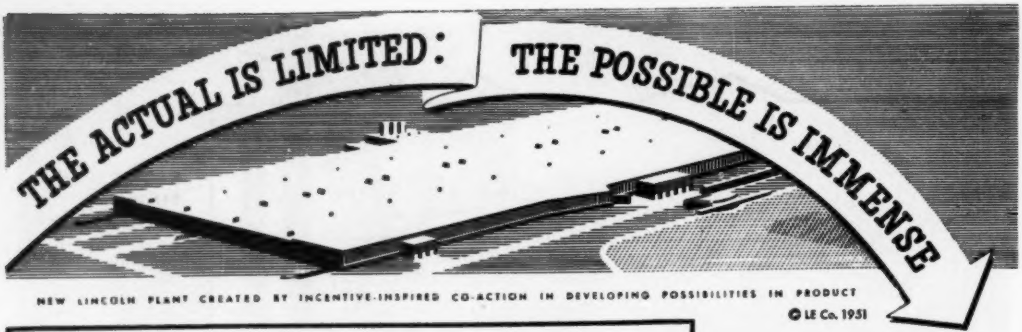
You can specify OIC Valves for any valving requirement and be assured of efficient, precise control. That's because OIC Valves are *precision engineered* and *precision built. Precision application* know-how of OIC engineers is available to help you select valves best suited to each requirement.

Ask your local OIC distributor, or write us direct, for a free copy of the OIC Valve Cross-Reference Chart. The Ohio Injector Company, Wadsworth, Ohio.

OIC
FOUNDED 1883

VALVES

FORGED AND CAST STEEL · IRON · BRONZE



NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

© LE Co. 1951

DESIGNS THAT UTILIZE THE ECONOMIES OF WELDED STEEL ARE ALWAYS LOWER IN COST

1 There is a 2 to 1 advantage pound per pound between the cost of steel and iron.

2 Considering both strength and safety factors, there is an additional 4 to 1 advantage with steel.

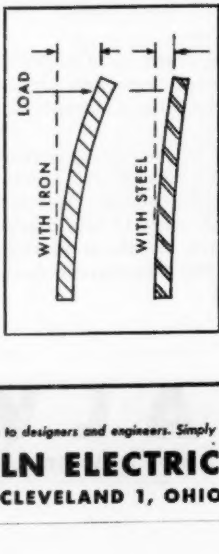
3 The design advantages are unlimited. Through origineering,* the designer is better able to locate the stronger materials in strategic areas, achieving maximum load-carrying capacity per pound of metal.

4 Production efficiency is greater. The shop can fabricate economically in any quantity . . . with a minimum of equipment and setup cost.

A Challenge to Industry

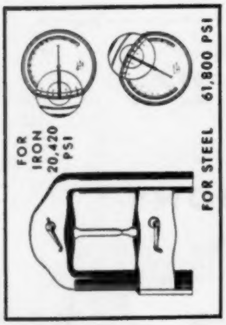
The greater potential economies possible with welded steel originate with design. To utilize the full benefits of steel requires new concepts in mechanics and appearance. Your Lincoln Welding Engineer can show you how to achieve these benefits in your designs . . . to build better products from less material at lower cost. Write The Lincoln Electric Co., Cleveland 1, Ohio.

*Origineering . . . the science of originating new engineering designs.



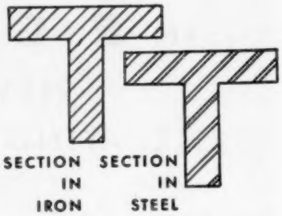
Steel is Twice as Stiff. *Only half the material is needed in welded steel designs to achieve equal rigidity.*

Steel is Ductile. *Withstands impact and shock without fracturing.*



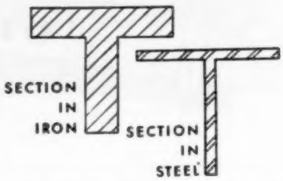
Steel is 3 Times Stronger. *Has 4 times the resistance to fatigue.*

the ACTUAL



Saves 50% Material Cost *by duplicating cross section in steel.*

increasing the YIELD



Needs 60% Less Metal *to achieve equal strength in bending.*

the IMMENSITY of the POSSIBLE

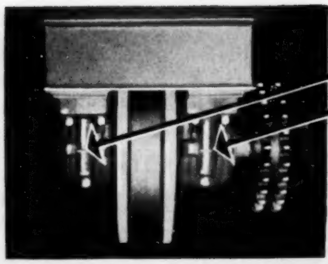
An initial 7 to 1 cost advantage with welded steel

SEE HOW WELDED STEEL CUTS COSTS

Machine Design Sheets are available to designers and engineers. Simply write on your letterhead to Dept. 402

THE LINCOLN ELECTRIC COMPANY

CLEVELAND 1, OHIO



Strobel & Salzman, Engineers
Petroff & Clarkson, Architects

Now an aircraft hangar with a zipper

on 32 pillow blocks by SKF

Here's the newest development in equipment for fast, time-saving, cost-cutting turnaround maintenance, inspection and emergency repairs for commercial aircraft. It's the Mitchell Mobilhangar*, built in two parts. Taxi aircraft into position—push-button controlled motors close the equipment to provide all the facilities of a fully equipped hangar. The Mobilhangar has every facility for servicing aircraft of any size. Tracks for it can be laid easily anywhere. Opening and closing operations are made smooth and easy by means of trucks equipped with 32 SKF Spherical Roller Bearing Pillow Blocks—a wise choice based on confidence in SKF's ability always to help put the right bearing in the right place, however unusual the service. 7215

*For information—including startling cost analyses—write Mitchell Mobilhangar Corp., 509 Fifth Ave., New York 17.

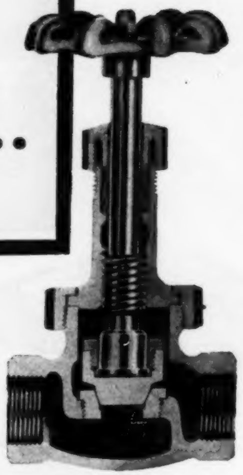
8 REASONS WHY SKF IS PREFERRED BY ALL INDUSTRY

- integrity
- craftsmanship
- metallurgy
- tolerance control
- surface finish
- product uniformity
- engineering service
- field service

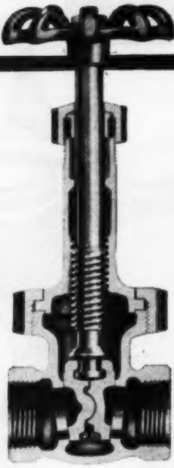
SKF
BALL AND ROLLER BEARINGS AND PILLOW BLOCKS

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
—manufacturers of SKF and HESS-BRIGHT bearings.

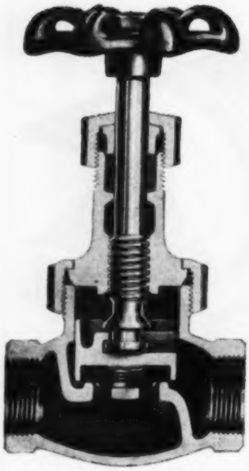
Walworth bronze valves...



Walworth No. 225P Globe Valve
500 Brinell Seat and Disc



Walworth
No. 29 Gate Valve



Walworth No. 95 Globe Valve
Re-New-Disc

built to give dependable trouble-free service on all recommended jobs

Walworth No. 95 Bronze Globe Valves (Angle Type: No. 96) are recommended for service where throttling is not required. They are rated at 150 psi working steam pressure, 500F; 300 psi cold water, oil or gas. The improved renewable disc and lock-on, slip-off disc holder — an original Walworth development—saves time and trouble. This valve can be repacked under pressure when fully opened. All parts are designed to give maximum service and strength.

Walworth No. 29 Bronze Gate Valves are rated at 200 psi working steam pressure, 550F; 400 psi cold water, oil and gas. These valves have rising stems and integral seats. Sizes 2-inch and smaller have union bonnets; sizes 2½ and 3-inch have bolted bonnets. Valves up to and including ¾-inch have solid wedge discs; 1-inch and larger have split wedge discs. These valves can be repacked under pressure when fully opened.

Walworth No. 225P Bronze Globe Valves (Angle Type: No. 227P) are rated at 350 psi working steam pressure, 550F; and 1000 psi non-shock service on cold water, oil and gas. The stainless steel, plug type seat and disc — heat treated to 500 Brinell — can be closed on sand, slag, scale and similar floatage, without injury to the seating surfaces. They are the longest wearing, TOUGHEST bronze valves you can buy.

For full information about Walworth Quality Bronze Valves, see your Walworth distributor, or write:

GLOBE

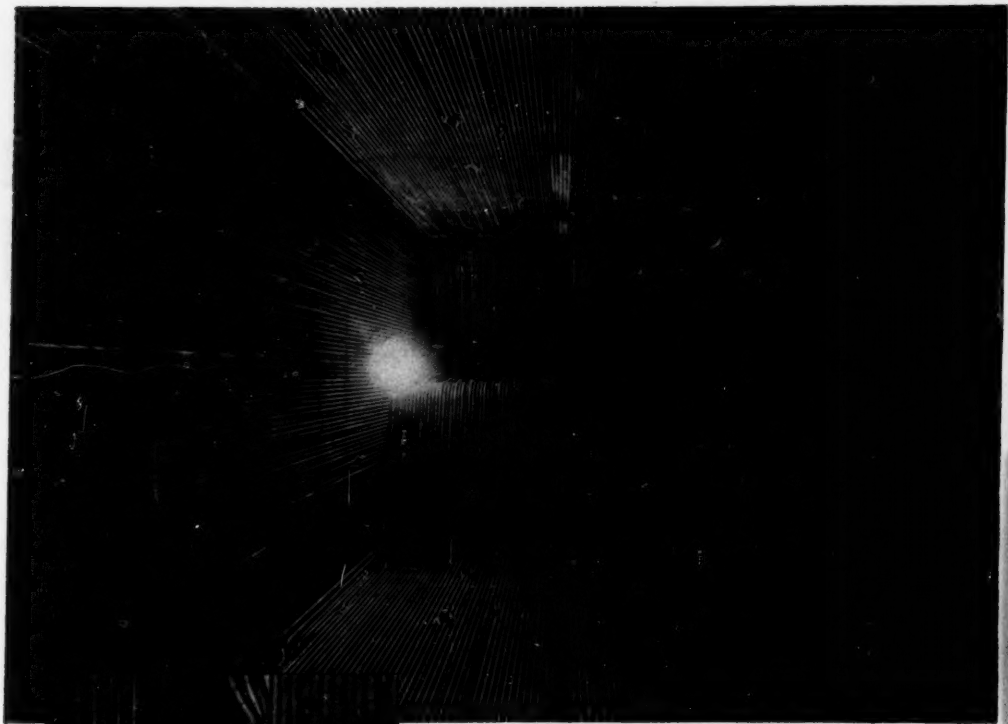
GATE

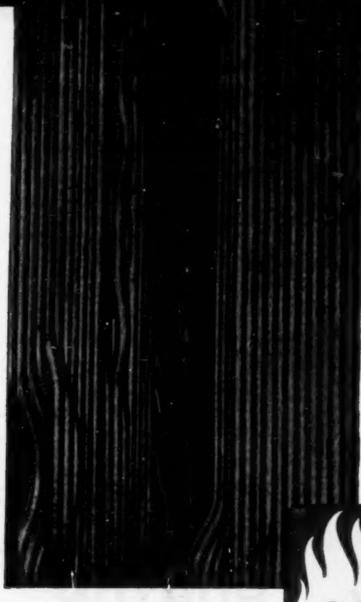
ANGLE

WALWORTH
valves and fittings
60 EAST 42nd STREET NEW YORK 17, N. Y.

CHECK

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD





Looking up 60 feet into the furnace* of a C-E Reheat Boiler. Observe that all four burners (detail at lower left) can be seen.

C-E Tilting Tangential Burners ... Best for Big Boilers

When a boiler furnace is big—like that shown above, for example—there's plenty of evidence to show that the best way to fire it is with C-E Tilting Tangential Burners.

Probably the most impressive point is the fact that in the postwar period—since 1945—more than 12-million kilowatts of new utility steam generated capacity has been installed or ordered equipped with C-E Tilting Tangential Burners. The record speaks for itself. B-471

*Photograph by Metropolitan Edison Co. at Titus Station. Gilbert Associates, Inc. of Reading, Pa., Engineers.

COMBUSTION ENGINEERING—SUPERHEATER, INC.

200 Madison Avenue • New York 16, N.Y.

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

HOW BOSTON *Gear*

HIDDEN QUALITY

SAVES YOU HIDDEN EXPENSE

BOSTON REDUCTOR — **BOSTON RATIOMOTOR**

To the naked eye, one power transmission unit may look just like another — so why not buy the one that costs a bit less? The answer, as many have learned from bitter experience, is that the difference in operating and replacement cost (the unforeseen or "hidden" expense) far exceeds the difference in purchase price.

Take the Case of the Production Welding Machine

A large unit was designed around a low priced speed reducer that gave out in a few weeks and had to be replaced by a BOSTON Reductor. Here is the cost picture:

Net difference in first cost	+ $ 10.50
Cost of repairing machine and replacing gear unit (2 men, 5 hrs. @ $3.00 per hr.)	− 30.00
Loss of production (5 hrs., 12 parts per hr. @ $24.00 per part)	− 1,440.00
NET LOSS	$1,459.50

Take the Case of the Baking Oven

A cut price motorized speed reducer failed and was replaced by a BOSTON Ratiomotor.

Net difference in cost	+ $ 10.40
Cost of overhauling oven and installing new unit (2 men, 4 hrs. @ $3.00 per hr.)	− 24.00
An entire batch of pastry worth $20.00 was lost due to drive breakdown. This, plus production loss (4 hrs., 12 batches per hour @ $20.00 per batch) made a total loss of	− 980.00
NET LOSS	$993.60

Write for Catalog No. 55
It contains a wealth of useful data and selection charts

The *hidden quality* in BOSTON Reductors and Ratiomotors is very real, even if you don't detect it at first glance. It is the result of BOSTON *Gear's* strict materials control, master craftsmanship and rigid inspection system. This *hidden quality* plus the unequalled convenience and service obtainable from Authorized Boston Gear Distributors (*see adjacent list*) makes it true and lasting economy to:

Specify Standardized Boston Reductors and Ratiomotors

Design Them Into Your Equipment

Get Them From Nearby Stock

BOSTON GEAR WORKS

66 HAYWARD ST., QUINCY 71, MASS.

BOSTON *Gear* STOCKS ARE *Here*

at factory prices

Save time and money—assure yourself of uniform quality and parts interchangeability by standardizing on Boston Gear quality products—stocked at these Authorized Boston Gear Distributors—one near you!

AKRON, OHIO
Bearing Distributors, Inc.
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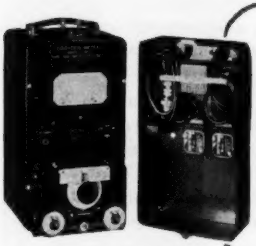

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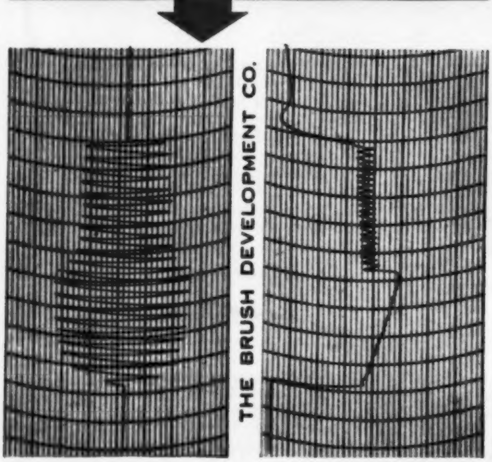

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Chart of welding cycle on Taylor Winfield welder shows 60-cycle A-c input current at left, D-c welding current at right. This Brush Analyzer consists of A-c amplifier, D-c amplifier, direct-writing oscillograph.

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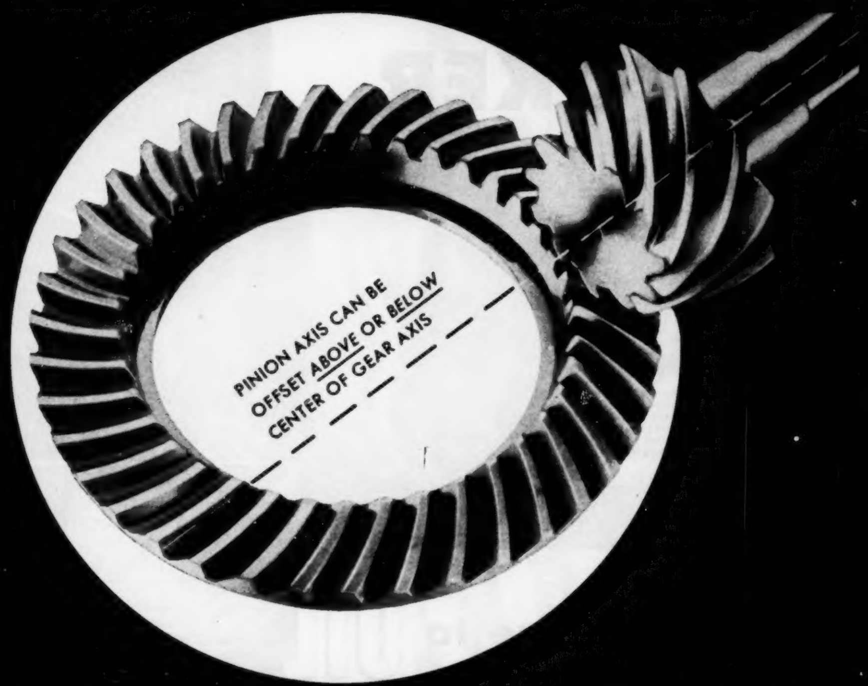

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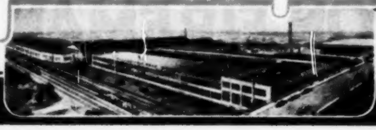

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For further information write to Iron Fireman Mfg. Co., 3149 W. 106th St., Cleveland 11, Ohio. Other plants in Portland, Oregon; Toronto, Canada. Authorized Iron Fireman dealers throughout the U. S. and Canada.

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For construction detail and operating principle of these CEC Pickups as well as description of indicating or recording equipment used with them, write for Bulletin 1507-X6. TORSIONAL VIBRATION may be measured with the Consolidated 9-102 Torsiograph described in the same Bulletin.

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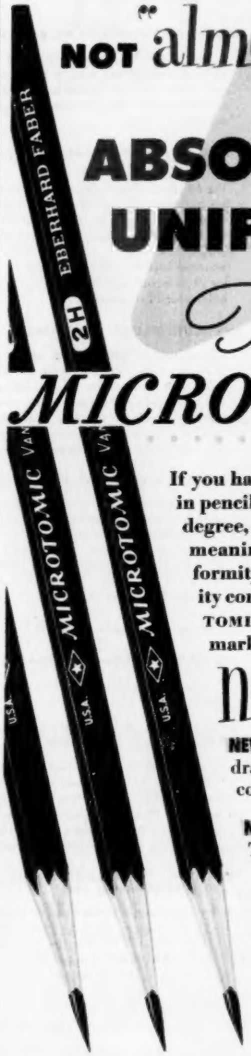

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SMALL TOOLS AND MACHINE TOOL ELEMENTS

American Standards

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ADJUSTABLE ADAPTERS, B5.11—1937. **60¢**

These adapters insure vertical adjustment for taper shank tools when used with multiple spindle drilling heads. General dimensions of assembly, detail dimensions for adjustable adapter body, and general dimensions for adjustable adapter nuts are included along with specifications for material, finish, marking, and tolerances.

CHUCKS AND CHUCK JAWS, B5.8—1936. **55¢**

Establishes controlling dimensions for all chucks from 6-in. to 36-in. diameter of both medium and heavy duty types, for an extra heavy series of chucks with serrated master jaws, for power-operated and hand-operated chucks of two-, three-, and four-jaw types.

CIRCULAR AND DOVETAILED FORMING TOOL BLANKS, B5.7—1948. **75¢**

The 62 types of machines for which tool blanks and holders are provided are classified into six different groups of comparable stock capacities. Dimensions are given in this Standard for (a) circular tools with threaded mounting hole for groups 1, 2, and 3; (b) circular tools with counter-bored mounting hole for groups 4, 5, and 6; (c) dovetailed tools for all six groups, and (d) circular forming and dovetailed tool holders for all six groups.

INVOLUTE SPLINES, B5.15—1950. **$2.00**

Tables give dimensional and effective clearances, minor diameter fits, dimensions for both the flat root and fillet root types, basic measurements between and over pins, special pin measurements, and hob and broach dimensions. Provisions are made for allowable errors. Formulas are given for calculating pin measurements and torque capacities. Suggestions are included for placing dimensions and data on drawings.

INVOLUTE SERRATIONS, B5.26—1950. **$1.00**

Provides a uniform, easily fabricated set of serrations that can be made by several manufacturing processes. Scope is from 0.10 diameter to 10.00 diameter. The pitches included are 10/20, 16/32, 24/48, 32/64, 40/80, 48/96, 64/128, 80/160, 128/256 complete from 6 to 100 teeth only for the first three. Here too provisions have been made for allowable errors and effective fits. New basic measurements between and over pins are given, also tables of maximum tooth space and minimum tooth thickness.

JIG BUSHINGS, B.56—1941, REAFFIRMED 1949. **45¢**

Dimensions for: Press-Fit, Renewable-Wearing and Liner Bushings.

PUNCH AND DIE SETS FOR TWO-POST PUNCH PRESS TOOLS, B5.25—1950. **75¢**

These dimensions are for back-post and diagonal-post sets. Tolerances established assure a high grade of tool which can be maintained commercially in respect to component parts and assembly. Dimensions cover die area, the die holder and punch holder thickness, shank diameters and lengths, guideposts and bushings, and removable punch holder shanks.

ROTATING AIR CYLINDERS AND ADAPTERS, B5.5—1932, REAFFIRMED 1949. **45¢**

The four sizes of adapters standardized are: for the 3- and 4½-in. cylinders, the 6- and 8-in. cylinders, for all sizes of cylinders from 10 to 18 in., inclusive, for the 20-in. air cylinder or other power-operated device having a draw rod pull of 26,000 to 40,000 pounds. The length of stroke of the Standard cylinders, the position of the piston rod at the end of the stroke, the diameter of the piston rod, and the size of the tapped hole in the piston rod have also been standardized.

SINGLE-POINT CUTTING TOOLS AND TOOL POSTS, B5.22—1950. **$1.25**

Standard defines and illustrates the different classes of tools, their parts, and the angles at which they are used. Preferred dimensions are for: tool shanks, tool post openings, and lathe center height for solid tools and tool holders; six styles of sintered carbide tips (their commercial catalog numbers are also given), and the tips and shanks of tipped tools.

MARKINGS FOR GRINDING WHEELS, B5.17—1949. **30¢**

Covering markings only, this Standard establishes a symbol for each of the most essential characteristics of a grinding wheel and arranges them in uniform sequence.

SPINDLE NOSES, B5.9—1948. **85¢**

These Spindle noses are for use on tool room lathes, engine lathes, turret lathes, and automatic lathes. Dimensions cover each size and type of nose; mating backs of chucks, face plates, and fixtures; and gages for checking important dimension on spindle noses and on back of chucks, face plates, and fixtures. There are instructions for drilling balancing holes for Type A spindle.

SPINDLE NOSES AND ARBORS, B5.18—1943, REAFFIRMED 1949. **30¢**

Provides the essential dimensions for ends of arbor and adapter and for spindle nose, also dimensions for draw-in bolt end.

T-SLOTS, THEIR BOLTS, NUTS, TONGUES, AND CUTTERS, B5.1—1949. **45¢**

The primary purpose of this standard is to insure interchangeability. To accomplish this it recommends a width of throat greater than the nominal diameter of the bolt. It also provides an alternative standard having the throat width equal to the nominal diameter of the bolt. Other recommendations provide for the use of a stud of a smaller size than the T-bolt for the corresponding slot; that T-bolts, nuts, and slots be known by the diameter of the bolt; and for chamfering corners.

LIFE TESTS OF SINGLE-POINT TOOLS, B5.19—1946. **55¢**

These test methods are for the appraisal of single-point cutting tools—for use on such machine tools as lathes, turret lathes, boring mills, planes, and shapers. These tests apply to speed, feeds, depth of cuts, shape and size of tools, Rockwell hardness, shape and size of test logs, etc.

TWIST DRILLS, B5.12—1950. **75¢**

Provides dimensions for standard straight shank drills varying from 0.0135 to 2.000 in.; taper shank drills from ⅛ in. to 3½ in.; the corresponding drill lengths and flute lengths. Tolerances have been set on the various features of drills to provide interchangeability of products of different manufacturers in user's plants. The sequence of diameters of the straight shank drills corresponds to actual sizes purchased and used in industry. All three series of number, letter, and fraction size drills have corresponding lengths.

MACHINE TAPERS, B5.10—1943, REAFFIRMED 1949. **75¢**

Presents (1) basic dimensions for 22 sizes of self-holding tapers; (2) detailed dimensions and tolerances for self-holding taper shanks and sockets classified as to (a) the means of transmitting the torque from spindle to shank of tool, and (b) the means of retaining the shank in the socket; (3) dimensions for steep tapers, and (4) dimensions and tolerances for the plug and ring gages applying to this series.

MACHINE PINS, B5.20—1947. **45¢**

Sets up dimensions for the following types of pins: hardened and ground dowel pins, straight pins, ground dowel pins (not hardened), taper pins, clevis pins, and cotter pins. An appendix gives specifications for taper pins and a drill chart for the size of drill and number required.

MILLING CUTTERS, B5.3—1950. **$2.25**

Reflecting the developments in cutter design, tool material, and machine improvements are the 56 types for which dimensions are here given. Supplementing the dimensions are descriptive illustrations of the approved milling cutter and a glossary of terms.

NOMENCLATURE FOR MILLING CUTTER TEETH, B5c1—1947. **70¢**

Meets the need for standard terms and definitions of parts of teeth of plain milling cutters; side milling cutters, and face milling cutters. It also includes a section covering definitions of speeds and feeds. Fourteen detailed drawings illustrate the text.

REAMERS, B5.14—1949. **$1.00**

General dimensions of thirty standard types of reamers and related tools are presented along with the magnitude and direction of the tolerances including the number of flutes in the various types.

TAPS—CUT AND GROUND THREADS, B5.4—1948. **$1.50**

32 tables give the thread and general dimensions together with the working tolerances for nine types of taps. Supplementary material includes terminology and definitions and instructions for marking taps, dies, and other threading tools.

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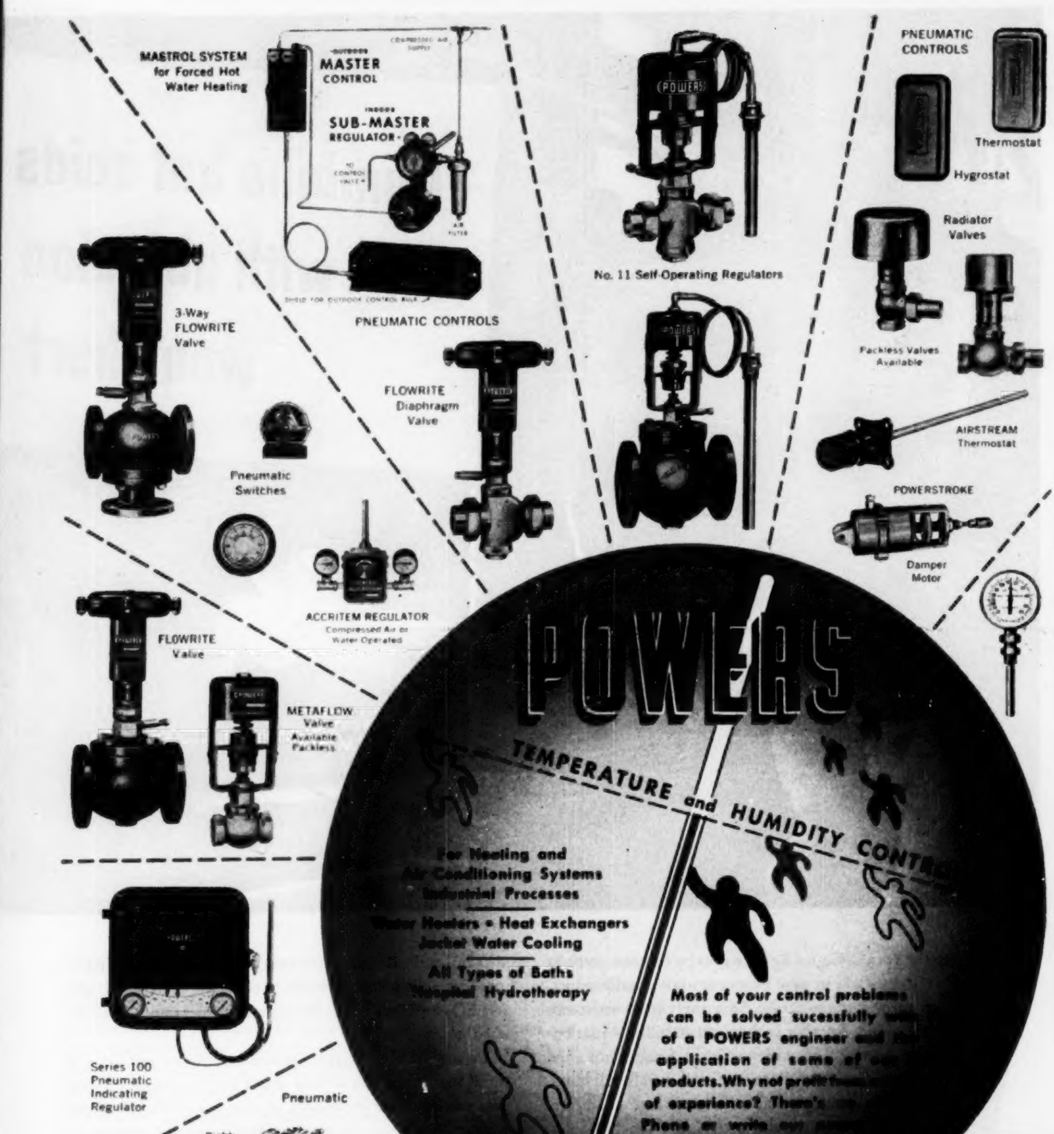
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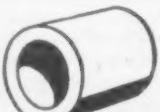
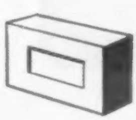
An example of an application where these characteristics are important is in ducts to and from SO_2 converters. Here, high velocity SO_2 and SO_3 gases at 1100°F create very corrosive and erosive conditions. To counteract the chemical attack and the scouring action of these gases, linings made of CARBOFRAX silicon carbide material (one of the Super Refractories by CARBORUNDUM) are used in all vulnerable portions of the ducts.

A quite similar use for CARBOFRAX linings is found in muriatic acid furnaces, hydrogen cyanide converters, SO_2 and SO_3 recovery systems, sulphur burners and other related equipment.

Do any of these suggest possible applications? Bear in mind that immunity to acid attack and resistance to abrasion are only two properties of this one particular Super Refractory. As you can see in the box opposite, CARBOFRAX materials have many other interesting characteristics.

Information on *all the types* of Super Refractories by CARBORUNDUM is now available in booklet form. It outlines just what these unique materials can be made to do. May we send you a copy? No obligation, of course. Just use the coupon on the opposite page.





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and you still
this material

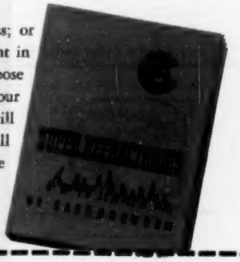
This advertisement — one of a series — is presented in the belief that in the unusual properties of the various Super Refractories by CARBORUNDUM lies the key to many new or improved processes. We would like to talk over specific jobs with anyone who sees such possibilities.

Principal characteristics of CARBOFRAX Super Refractories

- Outstanding abrasion resistance — at all temperatures from room to well above 2600°F. Successfully used to line coke and ore chutes and dust collectors. A good example of high temperature use is for skid rails in slab-heating furnaces.
- Far stronger, in all temperature ranges, than practically all other refractories.
- Very high thermal conductivity. Made-to-order for checkers, recuperator tubes and tile, muffles, hearths, linings for water-wall boilers, and similar applications.
- Low and uniform coefficient of expansion — .000005 per degree C between 25° and 1400°C. Spalling is rarely experienced.
- Readily withstand temperatures up to and often well above 3000°F. Excellent heat-shock resistance. Unaffected by temperature changes that will quickly ruin other refractories.
- Remain extremely hard at elevated temperatures, and therefore resist clinker or slag ahesions.
- Inert to acid attack.

CARBOFRAX refractories are available as brick and as special shapes molded to very close tolerances—including fitted joints, tubes, etc. They are not, however, a universal cure-all, and should be applied with caution where molten metallic oxides or molten bases are present. They will not withstand hydrofluoric acid. However, there are other Super Refractories by CARBORUNDUM that are applicable in these cases—particularly MULLFRAX electric furnace mullite, ALFRAX electrically fused alumina, and MONOFRAX fused cast refractories.

In our new booklet on Super Refractories, you'll find information about materials which, for example, are highly resistant to erosion by molten glass; or make excellent insulators; or are unusually light in weight. The special qualities of these special-purpose refractories may go hand-in-glove with one of your processes. Why not check up? The coupon will bring you the story—or one of our engineers will be happy to talk over your specific problems. We believe it could be mutually profitable.



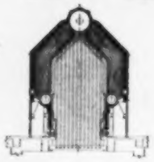
THE CARBORUNDUM COMPANY
Refractories Division **Perth Amboy, N. J.**

"Carborundum," "Carbofrax," "Monofrax," "Mullfrax" and "Alfrax" are registered trademarks which indicate manufacture by The Carborundum Company

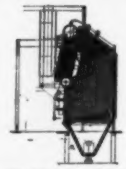
Dept. P-51
Refractories Div., The Carborundum Co.
Perth Amboy, New Jersey
Please send your free booklet on properties of Super Refractories
Name________
Position________
Company________
Street________
City________ **Zone**____ **State**____

If you need steam you need a Wickes steam generator

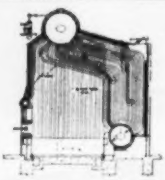
WICKES



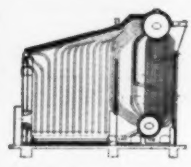
Crown "A" Type
Water Tube Boiler



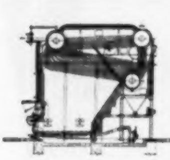
Type "T" Water Tube Boiler



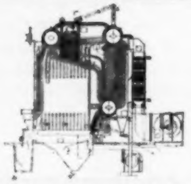
Type-S 2 Drum Boiler Series 51



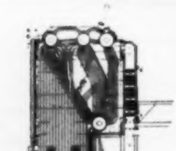
2 Drum Water Tube Boiler



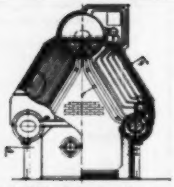
3 Drum Low Head
Water Tube Boiler



3 Drum "B" Type Water Tube Boiler



4 Drum Water Tube Boiler



N_2 Oil Fired Marine Service
Water Tube Boiler

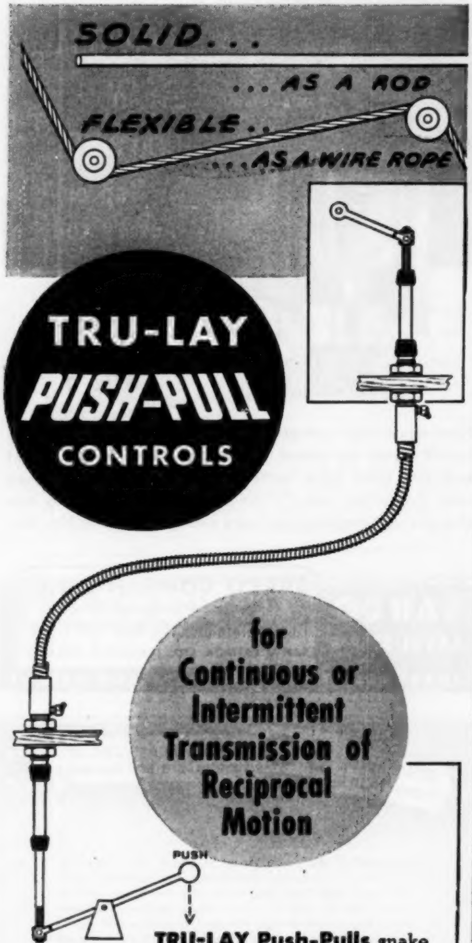
Wickes Steam Generators are in constant daily service in thousands of installations throughout the world. Wickes can fill your exact requirements for boilers of any type up to 250,000 lbs. steam per hour and 850 psi. • Wickes Boilers are engineered for use in oil, chemical, paper and many other industrial uses as well as marine service. Our knowledge of steam generation is available for your consultation, without obligation. Descriptive literature available upon request. • Remember — if you need steam you need a Wickes Steam Generator.

THE WICKES BOILER CO.
SAGINAW, MICHIGAN

SALES OFFICES: Atlanta • Boston • Chicago • Cincinnati • Denver • Detroit • Houston • Indianapolis • Los Angeles • Milwaukee • New York City • Pittsburgh • Saginaw • San Francisco • San Jose • Springfield • Seattle • St. Louis • Tulsa • Mexico City • Buenos Aires • Manila • Havana • Montevideo • San Juan, P.R. • Victoria, B.C.

DIVISION OF THE WICKES CORPORATION
RECOGNIZED QUALITY SINCE 1854

f31-A



TRU-LAY Push-Pulls snake around obstructions. Provide positive remote action. Operate while flexing, as on shakers. Few or many bends. Short or long distances. Ruggedly constructed for years of service. Capacities up to 1000 pounds input. Maximum travel 4″.

ACCO

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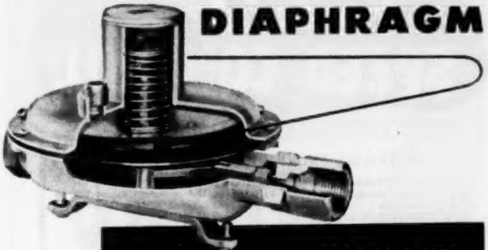
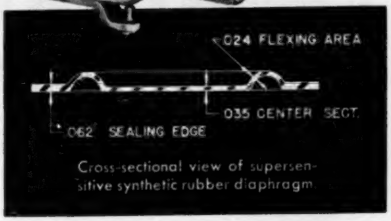
AMERICAN CHAIN & CABLE

In Business for Your Safety

CONSTANT DELIVERY PRESSURE ...*with a* LINEAR

PRECISION MOULDED DIAPHRAGM





Cross-sectional view of supersensitive synthetic rubber diaphragm.

Typical is the result obtained with the Linear Diaphragm, shown above. Precision moulded to a .062″ edge, .024″ at the flexing area, and .035″ in the center section, this super sensitive diaphragm assures a consistently uniform delivery pressure over a wide range of inlet pressures.

Detailed and expert attention to the need for minute variations in cross-sections and radii . . . coupled with application experience in the selection of specific materials . . . has enabled Linear to produce precision-moulded diaphragms with a rolling action that eliminates stresses, reduces hysteresis and increases life. Thus, Linear Diaphragms offer advantages that cannot be achieved with flat diaphragms . . . frequently at lower cost.

Produced under rigid supervision and held to the closest of tolerances, every single Linear Diaphragm can be depended upon . . . mighty important in these days of critical material shortages. For a lower rejection rate and easier installation, it will pay you to consult Linear during the design stages of your diaphragm applications.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA

ON YOUR PRODUCTS
or IN YOUR PLANT

LOVEJOY
Variable
SPEED CONTROL

INCREASES PRODUCTION

With "finger-tip" control, machines can be speeded up to increase production . . . . adjusted to the speedability of the operator . . . corrected to size or density of parts or stock—temperature or humidity.

REDUCES SHUT-DOWNS

With Lovejoy Variable Speed Control, costly shut-downs are eliminated in the process of changing the speed of the machine to meet varying conditions.

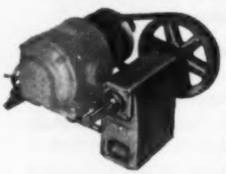
IMPROVES YOUR PRODUCT

Lovejoy Variable Speed Control permits the easy speed correction of your machines to compensate for varying conditions. The results . . . better products and fewer rejects.

INCREASES SALES

The machines you manufacture, when equipped with Lovejoy Variable Speed Control, have that "extra" sales appeal. Your customers appreciate this added advantage.

LOVEJOY VARIABLE SPEED PULLEY AND ADJUSTABLE MOTOR BASE



Available for fractional to 8 H.P. drives and speed ratios up to 3 to 1.

LOVEJOY SELECT-O-SPEED TRANSMISSION

With lever or hand wheel control. Sizes from fractional to 7½ H.P., and speeds up to 10 to 1 ratio.

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LOVEJOY FLEXIBLE COUPLING CO.

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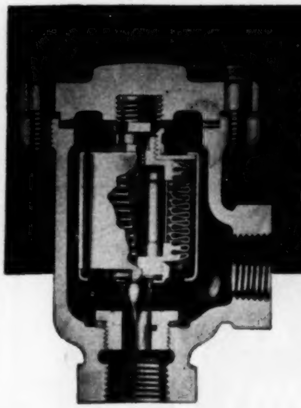
Also Mfrs. of Lovejoy L-R Flexible Couplings and Lovejoy Universal Joints



INDIVIDUAL STEAM TRAPPING
(A Trap on every coil)

SARCO
No. 9

Gets more heat out of the steam and more production out of steam equipment. The inexpensive, highly efficient trap that gives quick starts because it's wide open when cold. Capacities recently doubled. Can't freeze. No seat changes required when pressure changes. Catalog No. 250.

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SAVES STEAM

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SARCO CANADA, LTD., TORONTO 5, ONTARIO

IMPROVES PRODUCT QUALITY AND OUTPUT

MPB makes more than 50 types and sizes of miniature ball bearings

BEARINGS, Ball, miniature. Standard and Special for application in precision mechanisms to minimize friction and wear. High load capacity in minimum space. Light in weight. Specify MPB for shock loads, continuous operation, extreme temperature ranges and delicate responsiveness. Special designs and complete engineering service for your application. Write for catalog M.

MPB MINIATURE *Precision* BEARINGS
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KEWANEE
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• For 6 to 36 H. P. at 100 lbs. W. P. Like a steel bridge you can't wear it down. Every part is accessible and it's easy to handle. *Truly trouble-free* and economical to operate. For Oil, Gas, Coal.

KEWANEE BOILER CORPORATION
KEWANEE, ILLINOIS
American Radiator & Standard Sanitary

For 6" Scale with pipe diameter markings—WRITE Dept. 99 - MS

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FLEXO JOINTS

Offer the Flexibility of HOSE the Strength of PIPE

For conveying pressures through moving pipe lines or to machinery or equipment while in motion, use dependable Flexo Joints. Complete 360° movement in either direction for pressures from gravity up . . . long wear—low maintenance cost. Four styles—standard pipe sizes ¼" to 3".

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In Canada: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 13, Ont.

MECHANICAL ENGINEERING

April, 1951 CARD INDEX Vol. 73, No. 4

OPPORTUNITY ADVERTISEMENTS

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications or a set of drawing instruments to dispose of; if you need help or want a position; in fact, anything to be offered that somebody else may want or anything wanted that somebody else may have—use a classified advertisement in the Opportunities Section.

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The American Society of Mechanical Engineers
29 West 39th Street New York 18, N. Y.

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VENUS DRAWING PENCILS

- **ACCURATELY GRADED** —in 17 degrees
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- **SMOOTHER** —the lead is *Colloidal* processed*

*Exclusive Venus patent

Uniform lines in weight and tone. Opaque lines for sharp, clear reproduction. Strong points, smooth in action. No smudge; no ghosts from erasures. There's the right degree for your favorite tracing papers. The result: sharper prints—*by any process!*

LOOK FOR THE GREEN CRACKLED FINISH!

FOR YOUR REFILLABLE PENCIL USE VENUS REFILLABLE LEADS —ACCURATELY GRADED

TRY Venus on your papers. Then see the print quality. Get Venus *Technical Test Kit* with pencils in the degrees you want . . . . . **FREE!**

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AMERICAN PENCIL COMPANY
Hoboken, New Jersey Dept. ME551

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Name ....

Company ....

Street ....

City .... *State* ....

HE'S HEADIN' FOR A HEADACHE

...are you?

Nearly every design engineer has had the same experience—developed a seemingly "perfect" new machine right up to the final blue print stage only to find hidden "bugs" that spell trouble ahead.

Often these "bugs" stem from bearings—their improper or inadequate application, *THAT IS!*

Most engineers, when confronted with anti-friction problems, turn to specialists—engineers who have accumulated years of experience and "know-how" in this one field. Such is the caliber of Aetna's engineering staff. Thanks to them, leading machinery manufacturers often save months of needless time, effort and expense in product development.

If you're heading for a headache which sound anti-frictioneering can forestall, consult Aetna. Whether you require new bearings or precision parts "designed from the ground up", or merely help in selecting standard bearings, Aetna stands ready to solve your problems in the shortest possible time and at the lowest possible cost. Aetna Ball and Roller Bearing Company, 4600 Schubert Avenue, Chicago 39, Illinois.

Aetna

Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Precision Parts

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Corrosion Resistance
Strength in Tension and Compression
Hardness & Toughness
Pressure-Tightness
Resistance to Erosion
Resistance to Frictional Wear
Fatigue Resistance

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Most certainly there is one of "our own alloys," or one of the many non-ferrous alloys we make that will meet your exact requirements—At any rate, our long and varied experience as Metallurgical Engineers and Founders is at *your service* for any problem or product you may have.

Please send me a copy of your latest "Reference Book of Bronze Casting Alloys."

AMERICAN MANGANESE BRONZE COMPANY

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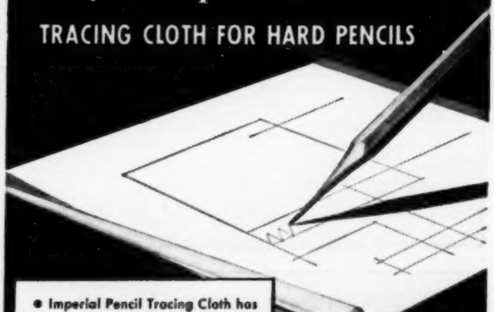
PITTSBURGH, PA.

Established 1909

Imperial

TRACING CLOTH FOR HARD PENCILS



• Imperial Pencil Tracing Cloth has the same superbly uniform cloth foundation and transparency as the world famous Imperial Tracing Cloth. But it is distinguished by its special dull drawing surface, on which hard pencils can be used, giving clean, sharp, opaque, nonsmudging lines.

Erasures are made easily, without damage. It gives sharp, contrasting prints of the finest lines. It resists the effects of time and wear, and does not become brittle or opaque.

Imperial Pencil Tracing Cloth is right for ink drawings as well.

Imperial

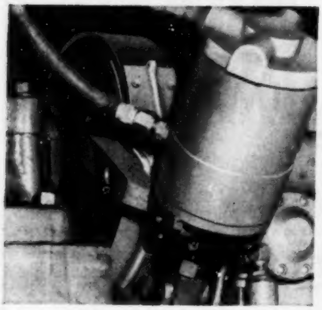
PENCIL TRACING CLOTH

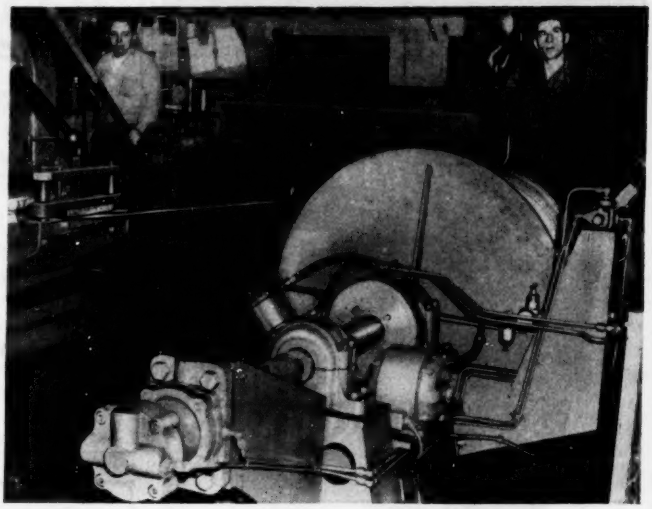
SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE

Effective Control Without Overheating!

TDA BRAKES

SOLVED THIS PROBLEM FOR GOOD!





Too much heat—not enough control! That was the problem of the Brainard Steel Company until they equipped their "Pay-out Reel" with a TDA Duo-Grip Brake! This machine serves the purpose of holding a coil of steel which is drawn into a cold rolling mill and then re-coiled. The brake is used to check the unwinding coil and, therefore, is constantly engaged and constantly generating heat. The open brake drum area of the TDA Brake allows for rapid heat dissipation—adding to braking efficiency and eliminating a possible fire hazard! Moreover, this sturdy brake has proved to be simpler to maintain.

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Controlled rotation is often the key to high production output! Dependable, responsive brakes eliminate breakdowns—keep machines humming at a steady clip! Recognizing this important fact, alert manufacturers are standardizing on smooth, efficient TDA Brakes! They're taking full advantage of the more than 40 years of experience offered by TDA Brake Division—experience concentrated in a highly competent staff of brake technicians. Let TDA Brake Division put its forces to work in developing the specific type of brake you need to meet your exact requirements! Mail the coupon below for more information on how TDA Brakes can be applied to your product.

Here Are A Few Of The Many Products Which Can Be Equipped With TDA Brakes

Centrifuges • Compressors • Conveyors • Cranes Cream Separators • Diesel hook-ups • Dry cleaning machinery • Extractors • Hoists • Industrial electric trucks • Lathes (automatic) • Looms (textile) • Lumber mill machinery • Machine tools • Materials handling equipment • Motors • Packaging machinery • Paint mixers • Press brakes • Printing presses • Rolling mills • Shears • Warpers (textile) • Welding positioners • Winches • Automotive • Farm equipment Earth moving equipment • Construction equipment Public transportation.

IF IT ROTATES WE CAN BRAKE IT

TDA BRAKE DIVISION—DEPT. D-2
ASHTABULA, OHIO

Please mail brake information on these applications.

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COMPANY ______________________________

ADDRESS ______________________________

CITY ______________________ STATE __________

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TDA BRAKE DIVISION
THE TIMKEN-DETROIT AXLE COMPANY
ASHTABULA, OHIO.

Accepted TDA Co. Standard

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24 pages of informative engineering and application data on horizontal end-suction centrifugal pumps in sizes from 1/4 to 150 hp

Profusely illustrated—you can apply and buy directly from the Bulletin.

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3. **BROAD RANGE OF CAPACITIES,** from 5 to 5500 gpm
4. **WIDE RANGE OF HEADS,** up to 260 feet.

Bulletin is complete with product illustrations and descriptions, pump cross sections, parts lists, dimensional data in both diagram and chart form, easy-to-read pump selection tables and pages of useful pump engineering data.

WRITE TODAY FOR YOUR FREE COPY. Simply use a penny postcard and request Peerless Pump Bulletin No. B-2300.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION

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REPLACE INFLAMMABLE SOLVENTS

With Rustproof, Odorless, Instant Wetting

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Makes any kind of water RUSTPROOF and at the same time makes a low cost, efficient, neutral solvent. Replace inflammable cleaners, solvents, etc. with this practical detergent.

Outstanding for use on metal, plastics, glass, woodwork, ceramics, linoleum, etc.

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If not listed, write to us upon your Company letterhead, informing us under what product classifications your firm should be listed.

The American Society of Mechanical Engineers
29 West 39th Street, New York 18, N. Y.

NOW STANDARDIZED

3 Precision Controls for All Speed Problems

Here's governor standardization that "pays off". Now you can economically solve all speed-control problems with only three basic governors.

Costly special engineering is eliminated. Advanced design gives an unusual degree of flexibility . . . with precise speed control for all steam conditions. Results? Initial costs are lower . . . shipments are quicker . . . spare-parts inventory is reduced.

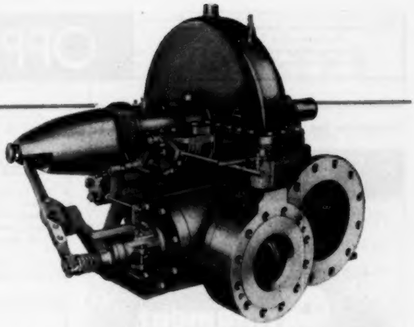
Designs for three basic classes of steam conditions, three wheel sizes, and three types of governors provide, in effect, twenty-seven standard variations to cover a wide range of applications. All oil-governed, direct-connected Type E units include the standard reservoir-type base, as illustrated. What's more, Type E governors can meet a great number of special requirements with optional accessories. This standardization results directly from Westinghouse's wide experience in all industry.

Other outstanding maintenance-saving features on the Type E turbine are Dual Protection . . . Weather Protection . . . Centerline Support . . . and a Rugged Governor Housing. Ratings are available from 5 to 1,500 hp.

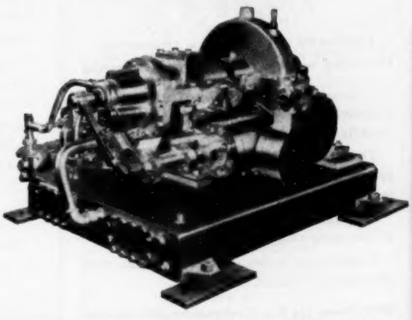
For complete information ask your nearby Westinghouse representative for Type E Turbine Book B-3896, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

YOU CAN BE SURE.. IF IT'S Westinghouse

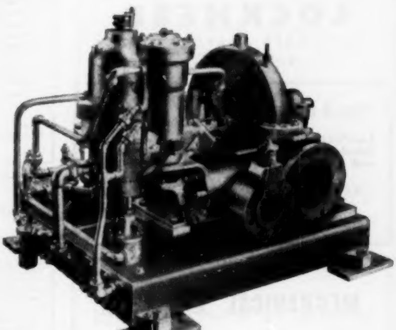
TYPE E Turbines



Shaft-Type Governor. For narrow speed-range applications, this governor automatically positions the steam admission valve to control turbine speed within close limits—*6 to 8% speed regulation.*



Hydraulic-Orifice Governor. For wide speed-range applications such as drives for fans, blowers, and compressors —*3-to-1 speed-adjustment range; 6% speed regulation.*



Vertical Oil-Relay Governor. For narrow-range precision-control applications such as drives for generators, pumps, blowers and compressors—*$33\frac{1}{3}\%$ speed-adjustment range; 4% speed regulation.*

J-50527

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Partnership—Capital
Manufacturing Facilities

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Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

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Lockheed offers you a chance to live and work in Southern California

Lockheed invites you to join its long-range production program, building the aircraft of today—and tomorrow.

This is your chance to make Lockheed's future your future—in an area where living conditions are beyond compare.

Increased pay rates and generous travel allowances offered.

Experience in design and installation of aircraft armament required.

Write today for free illustrated booklet, describing living and working conditions at Lockheed in Southern California. Address:

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Employment Manager

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AIRCRAFT CORPORATION
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Excellent permanent openings with a well established national manufacturer for Graduate M.E.'s with initiative and 8 or more years' experience.

ADVANCE TRANSFORMER COMPANY
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Large Western New York Chemical plant, noted for its high-quality manufacturing standards, has attractive permanent position for mechanical engineer with 2 or 3 years' industrial experience on plant engineering projects. Liberal starting salary, with periodic review of performance for salary increases. Excellent working conditions, cafeteria, pension plan, plus group life, sickness and accident insurance.

Address CA-3479, care of "Mechanical Engineering."

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Continued on Page 105

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Five Pages of "OPPORTUNITIES"

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Continued on Page 108

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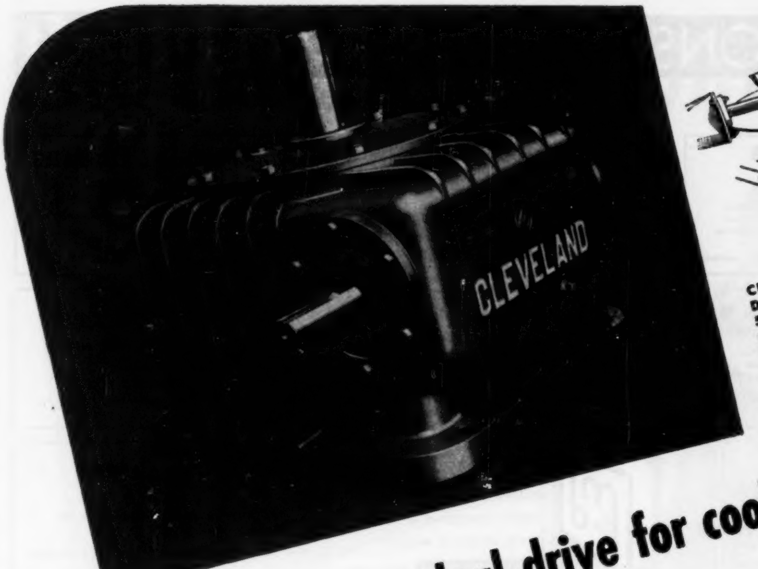

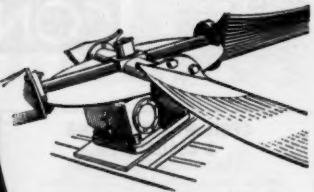

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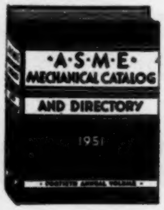

★ The asterisk indicates that firm also has product catalog in the 1951 ASME Mechanical Catalog and Directory

The Only Reference Annual Covering the Mechanical Engineering Field with a Unique Combination of Complete Equipment Directory and Manufacturers' Catalogs. Up-to-date 20-page Insert Catalog of ASME Publications is included. *Published Annually.*

CONSULTING SERVICE . . . Page 110

Advertisers in previous 1951 issues but not in this issue

MECHANICAL ENGINEERING, 29 W. 39th St., New York 18, N. Y.

Additional information is requested on the following advertisements in the May 1951 issue

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Name______________________________ Title______________

Company____

Address____

City______________________________ State______________

Reader Service Coupon For More Information

Go through the advertising pages and jot down the page numbers and names of advertisers about whose product you want additional information — mail the coupon to us — your request will be passed on to the advertiser promptly — you will hear directly from advertiser — saves your time in writing individual letters.

Westinghouse offers

OPPORTUNITY and SECURITY FOR

ELECTRICAL and MECHANICAL ENGINEERS

METALLURGISTS, PHYSICISTS, and CHEMISTS

IN DESIGN, RESEARCH, APPLICATION, DEVELOPMENT

investigate immediately!

See what Westinghouse offers you in the CAREER OF YOUR CHOICE.

Unlimited Opportunity—Good engineers have unlimited opportunity at Westinghouse where more than half of the top executives are engineers. They understand your language. They are proof that you can make your own future at Westinghouse. Right now we are building seven new plants. As new plants and divisions get into production, many supervisory posts will be filled from our engineering staff.

Security—Nearly all of the engineers who joined us in World War II are still with us, and in the past 10 years our total employment has almost doubled. These are not temporary jobs.

Participation in the Defense Effort—In 1951, a large part of all Westinghouse production will be to satisfy the nation's military needs.

Minimum Experience Required—2 years . . . but some of these openings call for top-flight men with more experience.

Salaries — Determined individually on the basis of the experience and ability of the applicant.

Location—There are openings for engineers, metallurgists, physicists, and chemists at most of Westinghouse's 36 plants. For example: you'll find opportunities to do jet engine work at Kansas City, Missouri and South Philadelphia, Pa. . . . in Ordnance manufacturing at Sunnyvale, California and Sharon, Pa. . . . on atomic power projects in Pittsburgh, Pa. . . . in radar and electronics at Baltimore, Md. . . . in aircraft equipment and fractional horsepower motors at Lima, Ohio . . . and in commercial and airport lighting at Cleveland, Ohio . . . and in power producing equipment to speed the production lines of America. And all of these activities have a definite and established peacetime application.

WESTINGHOUSE OFFERS YOU IN ADDITION TO GOOD PAY

—Help in finding suitable housing.

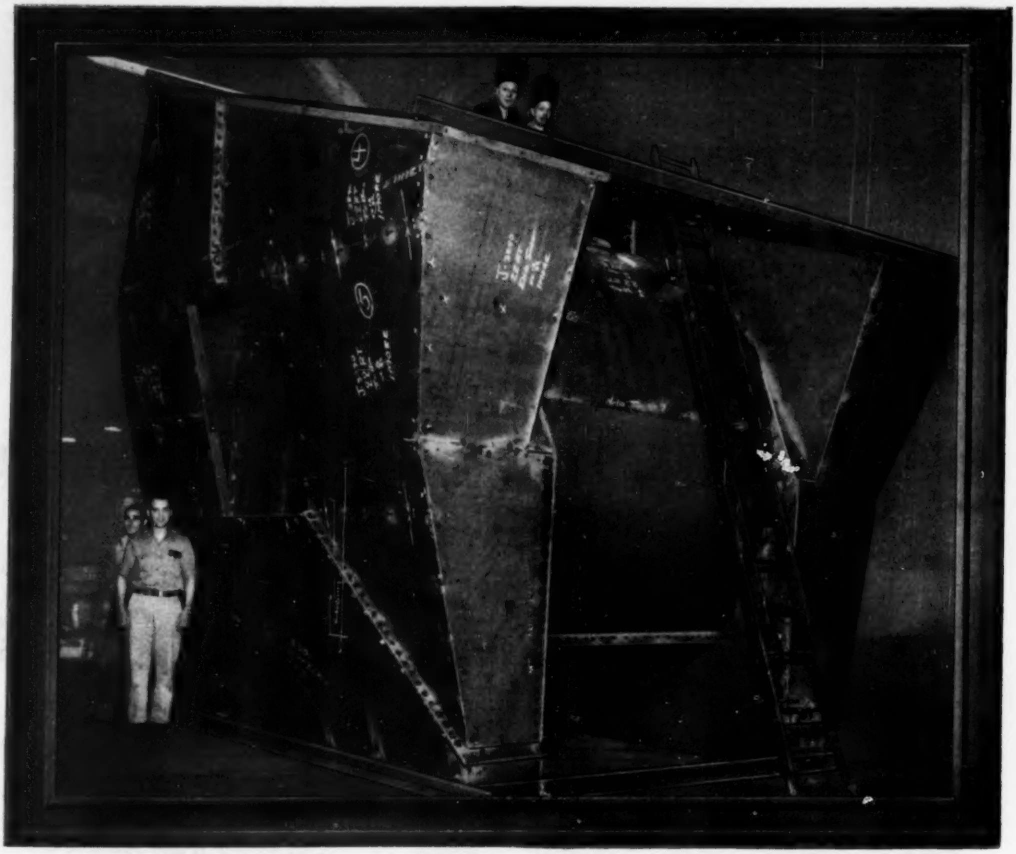
—Low cost life, sickness and accident insurance with hospital and surgical benefits.

—Modern pension plan.

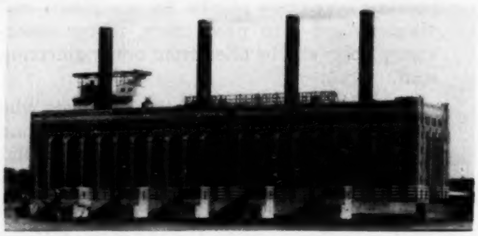
—Opportunity to acquire Westinghouse stock at favorable prices.

—Privilege of buying Westinghouse appliances at employe discount.

**Investigate Westinghouse today . . . write Mr. R. P. Meily,
Westinghouse Electric Corporation, Box 2163
306 Fourth Ave., Pittsburgh 30, Pa.**



J-3290 Was Quite an Order



CUSTOMER: Central Illinois Light Co.
SERVICE: Power Plant Induced Draft
SIZE: No. 22 RT — 38,278 Pounds
CAPACITY: 330,000 C.F.M. at 325° F.

Photographed above is one of the largest induced draft fans in the world under construction in the Clarage plants. This heavy-duty fan equipment now serves a 600,000-pound boiler at Central Illinois Light Co., Peoria, Illinois.

To date over 3,000 power plants are Clarage equipped. If you are looking for the *utmost in performance and dependability*, it certainly will pay you to consult with us.

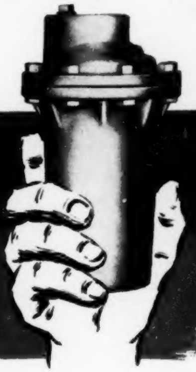
CLARAGE FAN COMPANY
KALAMAZOO, MICHIGAN

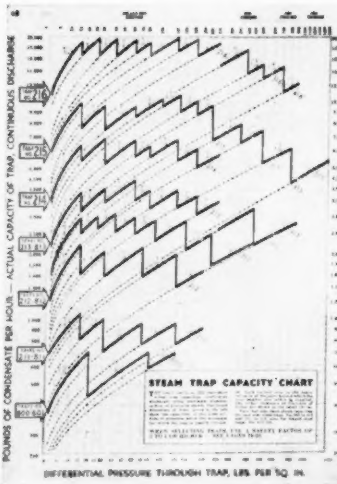
CLARAGE
—HEADQUARTERS for Air Handling and Conditioning Equipment

Sales Engineering Offices in All Principal Cities

Only actual hot condensate capacities give a true picture of steam trap value

YOU KNOW THE CAPACITY WHEN YOU BUY AN ARMSTRONG





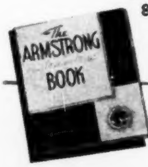
IT PAYS TO KNOW BEFORE YOU BUY! THE ARMSTRONG STEAM TRAP CAPACITY CHART is based on hundreds of tests with hot condensate. You can depend on its accuracy.

THEORETICAL calculations fail entirely to give a true picture of trap capacity. Orifice tests fail to account for capacity losses caused by pipe friction. Tests with cold or warm water do not take into consideration the capacity-reducing effect of flash steam. Only tests with actual trap hookups handling hot condensate will tell you the true continuous discharge capacity of a steam trap—and those are the capacities Armstrong gives you.

If capacities are misleading you may buy a trap too small for the job. Or, if you compare different makes of traps on a price basis you must know if they are comparable on a capacity basis or the comparison means nothing.

Dollar for dollar and size for size Armstrong steam traps give you greater capacity—another reason why they are your wisest buy. Your nearby Armstrong Representative can supply you. Call him for recommendations.

ARMSTRONG MACHINE WORKS
894 Maple Street • Three Rivers, Michigan



The 36-PAGE STEAM TRAP BOOK gives Armstrong trap capacities and tells how to select the right size trap for every job. Ask for a copy.

SEE OUR CATALOG IN SWEETS OR CEC

ARMSTRONG STEAM TRAPS

For high precision gear trains TIMKEN® bearings are just the ticket

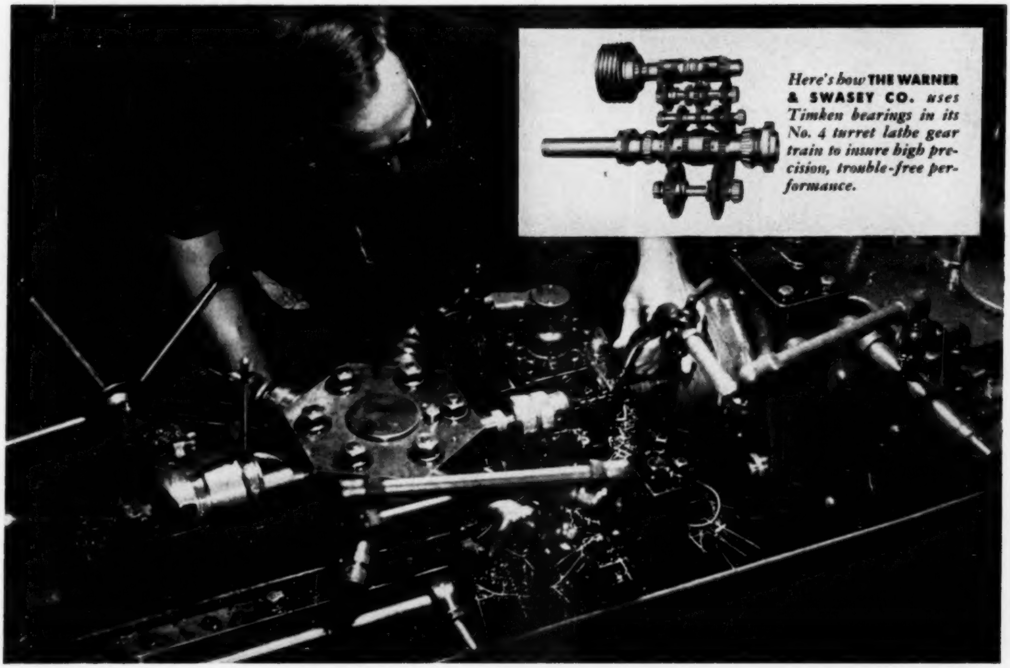
THE No. 4 Warner & Swasey turret lathe shown below is machining precision parts for airplane engines. To insure the high precision called for, Warner & Swasey uses Timken® tapered roller bearings on the spindle and throughout the gear train.

Because Timken bearings are tapered, they take any combination of radial and thrust loads. And due to the line contact between rollers and races, Timken bearings provide extra load carrying capacity. Result: Shaft deflection and end-movement are minimized. Shafts are held in rigid alignment. Gears mesh smoothly. Spindle precision is assured day in, day out.

Timken bearings are made from Timken fine alloy steel—the finest ever developed for tapered roller bearings. Rollers and races are case hardened, producing hard, wear-resistant surfaces and tough, shock-resistant inner cores. True rolling motion and smooth surface finish combine to make Timken bearings practically friction-free. They normally last the life of the machine in which they're used.

For the best value in machine tools look for the "Timken bearing equipped" label. For the best value in bearings look for the trade-mark "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



Here's how **THE WARNER & SWASEY CO.** *uses Timken bearings in its No. 4 turret lathe gear train to insure high precision, trouble-free performance.*

IT'S TIMKEN BEARINGS FOR VALUE!

To get the best value in bearings you may find this simple formula helpful:

$$\textit{Value} = \frac{\textit{quality} + \textit{service} + \textit{public acceptance}}{\textit{price}}$$

Obviously a big advantage *above* the line gives you more value than a small one *below*. No other bearing can match the uniform high quality, engineering and field service and overwhelming public acceptance you get with Timken bearings.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION